THE WORLD IS ITS FIELD.

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THE INDUSTRIAL SIGNIFICANCE OF THE ANGLO-GERMAN ALLIANCE.

An Editorial Review.

THE future of China may be said to be practically settled by the Anglo-German agreement—insomuch the more because this pact repeats and enforces the principles already declared by the United States Government. And this triune agreement between the three great manufacturing nations of the earth marks an event of supreme importance to men of foresight who are concerned with industrial development. Latest in time, broadest in possibility, this event is also furthest advanced in the evolution of economics and politics—the first great recognition of the newly-conceived attitude of the strong nations toward the weak one. For we begin to see now that this is the epoch of beneficence in dealing with alien races—that the material interests of a strong nation are best served by living up to the noble ideals so eloquently presented in these pages two years ago by Captain Mahan:

"Ideas underlie action," he wrote. "If the paramount idea of beneficence becomes a national conviction, we may stumble and err, we may at times sin, or be betrayed by unworthy representatives; but we shall advance unfailingly.

"We have the two great examples. Great Britain has been, in the main, and increasingly, beneficent and strong. Spain from the very first, as the records show, was inhumanly oppressive to the inferior races; and, after her own descendants in the colonies became aliens in habit to the home country, she to them also became tyrannically exacting. But, still more, Spain became weaker and weaker as the years passed, the tyranny of her extortions being

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partially due to exigencies of her political weakness and to her economical declension. Let us, however, not fail to observe that the beneficence, as well as the strength, of Great Britain has been a matter of growth. She was not always what she now is to the alien subject.

"The writer believes firmly in the ultimate power of ideas. Napoleon is reported to have said: 'Imagination rules the world.' If this be generally so, how much more the true imaginations which are worthy to be called ideas! There is a nobility in man which welcomes the appeal to beneficence. May it find its way quickly now to the heads and hearts of the American people, before less worthy ambitions fill them; and, above all, to the kings of men, in thought and in action, under whose leadership the land makes its giant strides.

"Materially, the interest of the nation is one with its beneficence; but, if the ideas get inverted, and the nation sees in its new responsibilities, first of all, markets and profits, with incidental resultant benefit to the natives, it will go wrong. Through such mistakes Great Britain passed. She lost the United States; she suffered bitter anguish in India; but India and Egypt testify to-day to the nobility of her repentance. Spain repented not. The examples are before us. Which shall we follow?" *

The bitter schooling which England has had in South Africa, and the sorry blunders of the United States in the Philippines have taught the Great Powers, as was pointed out in an editorial in these pages last September, that the difficulties of world politics are made greater, not less, by the assumption of "the enormous load of the actual direction of the affairs" of huge sections of the race in semi-civilised lands; that the true course is "the inspiring, advising, and to a large degree the organising of a new and wisely-progressive government which, to the greatest extent possible, should be permitted and led to work out its own order. * * * This, and not the stupendous attempt to raise the mass by outside agency, should be the end to which the best efforts of Europe and America should be directed."† The political jingoes have had a warning which they can never again forget nor ignore. The strength of the "anti-imperialist" movement in the United States has made the handwriting on the wall plain enough there. And Great Britain, as the Hon. John Barrett recently wrote, "is now face-to-face with a growing sentiment against any further extension of her imperial domain, and has always led the agitation in favour of the open door. If the war in South Africa would seem to be inspired by a sentiment contradictory to this assertion, it, on the other hand, would appear to mark the limit of conquest which the English people would favour or permit."

* The Relations of the United States to their New Dependencies. THE ENGINEERING MAGAZINE, January, 1899, page 521.

† THE ENGINEERING MAGAZINE, September, 1900, page 802.

In short, the fearful cost of territorial acquisition in Africa and Oceanica has taught physically the lessons which the Hague Conference put morally and intellectually. The world has gained, from the sufferers by the Boer war and Spanish wars, the knowledge it rejected when formulated in the abstract by the peace commissioners. War and conquest do not pay. The appreciation of the fact is more vivid than ever it was before, and out of the turmoil of the close of the nineteenth century has come a firm and stable adjustment of ideals which holds high promise for the unbroken peace and growing industry of the twentieth. Russia, long regarded as the menace to European diplomacy, under the young Czar shows unmistakeable aspirations for peace and industrial development. The German Emperor has changed the *rôle* of war lord for that of the promoter of enterprise and the foster-father of commerce. What the preachers of peace could not impress upon the nations, the precipitators of war have written in blood and fire, and the lesson is learned.

The strong and direct sign of the change is the subsidence of the clamour for the partition of China and the generally-accordant working of the Powers for a common end—the restoration of order, the maintenance of the entity of the empire, the establishment of a secure internal government, and the opening of common opportunity for development of the country and for commerce with it. The event has justified our forecast of July—that "Europe and America will come to an agreement by which at least nominal autonomy for China will be preserved." * The agreement is as truly Anglo-American as if Mr. Chamberlain's suggestion had been formally fulfilled:

> "I would go so far as to say that, terrible as war may be, even war itself would be cheaply purchased if in a great and noble cause the Stars and Stripes and the Union Jack should wave together over an Anglo-Saxon alliance. (Prolonged cheers.)
>
> "The recent collapse of China has opened up one of the greatest questions of our time. Is this vast country, with untold mineral and other resources, and with a population of four hundred millions of frugal, industrious people, to be partitioned among European nations? Is the greatest potential market of the world to be permanently closed to general trade, or is it to remain open, with its incalculable possibilities, to all nations on equal terms? The interest of the United States in the decision is the same as that of Great Britain. If it should ever be necessary to enter into negotiations, in order to secure to all the world an equal opportunity in regard to this commerce, it cannot be doubted that they would be definitely more influential if backed by the joint action of the United States and Great Britain, than if either of these Powers held aloof."

* Editorial in THE ENGINEERING MAGAZINE, July, 1900, page 584.

The Anglo-German agreement is an actual instrument; the participation of the United States is one of unity of aim and sympathy as complete as any written bond could make it. Compare the declaration of Secretary Hay, quoted in these pages last August, with the text of the Anglo-German compact given out by the British Foreign Office on October 31:

"(1.) It is a matter of joint and permanent international interest that the ports on the rivers and littoral of China should remain free and open to trade, and to every other legitimate form of economic activity for the peoples of all countries without distinction, and the two Governments agree on their part to uphold the same for all Chinese territory so far as they can exercise influence.

"(2.) Her Britannic Majesty's Government and the imperial German Government will not on their part make use of the present complication to obtain for themselves any territorial advantages in Chinese dominions, and will direct their policy toward maintaining undiminished the territorial condition of the Chinese Empire.

"(3.) In case of another Power making use of the complications in China in order to obtain, under any form whatever, such territorial advantages, the two contracting parties reserve to themselves the right to come to a preliminary understanding as to the eventual steps to be taken for the protection of their own interests in China."

"The purpose of the President is, as it has been heretofore, to act concurrently with the other Powers, first, in opening up communication with Pekin and rescuing the American officials, missionaries, and other Americans who are in danger; secondly, in affording all possible protection everywhere in China to American life and property; thirdly, in guarding and protecting all legitimate American interests; and fourthly, in aiding to prevent a spread of the disorders to the other provinces of the empire and recurrence of such disasters.

"It is, of course, too early to forecast the means of attaining this last result, but the policy of the Government of the United States is to seek a solution which may bring about permanent safety and peace in China, preserve Chinese territorial and administrative entity, protect all rights guaranteed to friendly Powers by treaty and in law, and safeguard for the world the principle of equal and impartial trade with all parts of the Chinese Empire."

This is the policy which has been advocated by the body of well-informed authorities and industrial leaders who have discussed the question in these pages during recent years. It was first indicated by Messrs. J. S. Fearon and E. P. Allen, when they pointed out that America should ally herself with England in the interest of maintaining the central authority in China and the open door.* Minister Denby formulated it still more definitely, showing that England and

* The Chinese, and Recent Industrial Progress in China. November, 1898, page 165.

Germany recognise China as "the greatest market on earth for their manufactured goods, and the greatest field for industrial enterprise. They have no interest in dividing her up into hostile camps, in checking production, and paralysing progress. * * * It is the interest of the world to preserve the autonomy of China. It is particularly to American interest to do so."* And no single nation could effectively secure this end. The fact is, as we pointed out editorially in October, 1899, that "the newly-opened places of the world need, for their development, the federated effort of all the great nations." But perhaps the clearest voice of all was that of Hon. John Barrett.

> "If America, England and Germany will exert in unison the influence which each individually possesses, there will be no question as to the success of their policy. Once seeing that these three powers are in earnest, Russia and France will be compelled to join them." †
>
> "America's supreme concern in China, which appeals to the greatest number of her people, is the commercial opportunity. That is likewise Great Britain's chief concern, and should be that of Germany, France and Japan. * * * Looking candidly into the future, the United States will therefore endeavor, whether in co-operation with Great Britain and other nations or not, to preserve the integrity of the Chinese Empire and prepare the way for a legitimate, untrammelled, material exploitation of China's vast resources." ‡

So said Mr. John Foord in his article on "China in Regeneration" in these pages in August last: "Great Britain, the United States, and Japan can be confidently reckoned on to stand for the maintenance of equality of commercial opportunity throughout the Chinese Empire, and consequently to stand for the preservation of its integrity." So said Gen. Wm. Barclay Parsons, in the interview recorded in our editorial pages last July. The event affords a striking instance of the heed which the statesman of to-day has learned to pay to the productive, constructive, and commercial interests of the country—of the influence which the engineer, works manager, and the industrial leader may exercise, and *must* exercise, in so-called "affairs of state." For the modern state lives by and in its industries.

The action of the three great powers in the East is thus a clear acknowledgment that the leaders of thought and action see their fundamental interests to be identical. The great commercial rivals appear as political allies. Antagonism wanes as emulation waxes. The theorem that one nation's ruin is another's gain has gone into the

* THE ENGINEERING MAGAZINE, December, 1898, page 347.

† England, America, and Germany as Allies for the Open Door. THE ENGINEERING MAGAZINE, September, October, 1899.

The Crisis in China; Its Meaning for an Engineering Constituency. THE ENGINEERING MAGAZINE, September, 1900.

scrap-heap, with other dead dogmas of political economy. Equality of opportunity—rivalry in adaptation to it, is the newer ideal. England is urging the world to acceptance of her far-sighted and consistent support of the open door, at home and abroad. Germany and the United States recognise its wisdom at the long focus of the East; their eyes are not yet adjusted to see at the short range of home affairs, but the vision is gradually growing more distinct, and it may be forecast even now that the time is not far off when they, too, will acknowledge and accept the clear-eyed statesmanship of Cobden and Bright.

With the vast resources of the United States relieved from the menace of involvement in business upheaval and freed for the service of peaceful industrial development throughout the world; with the forces of Europe and America no longer engrossed in the jealousy of international struggle for extended political boundaries, but, by the great precedent of the Chinese settlement, united in keeping peace and order and maintaining, instead of remaking, the map of the East; with the marvellous increase in productive capacity of the last fifty years to build upon—the twentieth century opens with matchless promise for the productive forces of the earth and for those who "direct them for the use and benefit of man."

The hero of the future is the captain of industry, not the captain of armies. The struggle is to produce the most, and most cheaply—not to destroy the most and the most quickly. The strong nation is the one whose manufactures and whose merchant marine reach farthest in supplying the wants of the peoples, and return best laden with the needed goods of other lands. The keynote of success, the secret of power, is economy—economy in production, in methods, in management. The vast growth of manufacturing establishments must be met by adequate growth and adjustment in administration. Organisation must replace the individual supervision and control which was adequate even to the great works of a half century ago. In the study of works management lies the highway to larger success and wider influence than the material conditions of the past ever made possible. Before engineers and managers lies the duty of meeting the conditions—and the other great duty of using their influence and their power in the affairs of the nation, so that justice and wisdom may govern the state at home and abroad. The task is a responsible one, but home and foreign politics have proved, during the year just closing, the triumphant success which follows when the industry and commerce of the country speak clearly to its rulers.

WATER-TUBE STEAM GENERATORS FOR NAVAL SERVICE.

By B. H. Thwaite.

HAVING considered the comparative merits and disadvantages of the shell and water-tube type of steam generator, and their respective adaptability to the requirements of naval service, it remains to consider the chief representatives. Hardly a month passes without the addition of a new design to the many already on the market. Only the typical and basal forms can be considered.

In the large-tube class those selected are the Belleville and Babcock & Wilcox; the Niclausse and Dürr may be considered combinations of large- and small-tube construction; the small-tube type is represented by the Du Temple, Thornycroft, Yarrow, and Normand.

All water-tube boilers have certain broad characteristics:

1:—The firegrate placed immediately over a nest or group of large- or small-bore generator tubes.

2:—The generator tubes, fixed at varying angles of inclination and connected to each other in distinctive ways by means of collector boxes or headers.

3:—The water-and-steam drum in which the water level is maintained and into which the generator tubes pour their water and steam; various devices are provided in the drum to separate the steam and water, so that the steam can escape in a dry condition.

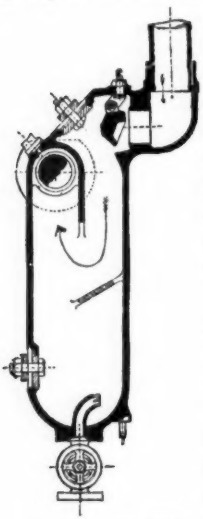
The Belleville Boiler. Anyone who has had to perform the difficult work of pioneering a new engineering departure—and especially a marine one—will realise in some measure the debt that progressive engineers owe to Mr. Belleville; to him is due the honour of having brought the large-water-tube boiler into the field of marine use.

The departure from the beaten track he indicated has been followed by far-reaching results, and his invention has been expanded in a remarkable manner, not only by the French marine but in foreign ones also. It may be also mentioned as a coincidence in favour of the progressive character of French practical science that we owe the remarkable innovation, the small-water-tube boiler, to a French officer, Commandant Du Temple; all the other designs of this small-tube type are based more or less on Du Temple's invention.

Mr. Thwaite's first article appeared in THE ENGINEERING MAGAZINE for November, 1900. The editors regret that space conditions absolutely prevent inclusion of Mr. Thwaite's excellent argument for homogeneity of steel for use in small water tubes, or his interesting section on automatic feed-water devices.

It is only just to the United States to mention that to its fertile soil of invention we owe the production of the most widely applied large-tube boiler for stationary purposes—the Babcock & Wilcox—besides that of the ingenious inventor Root.

In the most advanced or "economiser" type of Belleville boiler* the generating tubes are only slightly inclined from the horizontal ($2\frac{1}{2}°$); the tubes are of solid drawn steel. Twenty of these tubes (say 7 feet 6 inches long) complete a tube group, technically defined as an element. The ends of the tubes screw into malleable-iron collector boxes. The tubes constituting an element provide for a continuous passage from bottom to top for water and steam. Each tube group or element is connected at its lower end to a water chamber, and the top of each element is connected to the steam-and-water drum, this connection in every instance being located on the front end. In order to prevent the direction of the water currents from being disturbed by the rolling or pitching of the vessel, Mr. Belleville has invented an ingenious contrivance so located that all the water must flow through it before it can enter the lower water chamber; it acts also as a sediment collector.



SEDIMENT COLLECTOR, BELLEVILLE BOILER.

In the Belleville boiler the feed water is introduced, at a higher pressure than that of the steam, at the centre of the upper drum collector by means of a small non-return valve. It descends to the bottom of the collector and flows to the return water pipes. The introduction of the feed water naturally lowers the temperature of the water in the collector, and it is obviously inadvisable that it should be allowed to enter any of the tube groups or elements; to prevent this the tops of the latter are projected at least 8 inches above the bottom or invert of the drum collector. During the flow of water along the return pipes its temperature is gradually raised to a critical point, at

* The following table approximately represents the application of the Belleville boiler in terms of indicated horse power: France, built, 230,000, building, 145,300; Russia, built, 61,000, building, 197,000; Italy, building, 46,000; Germany, built, 10,000; Austria, built, 34,000, building, 24,000; Japan, built, 36,000, building, 50,000. In the list, 44 vessels are included of considerably over 10,000 indicated horse power each. The indicated horse power supplied to the British navy probably exceeds 150,000. It is stated that 41 millions sterling are embarked in British warships, already or in the course of being equipped with Belleville boilers.

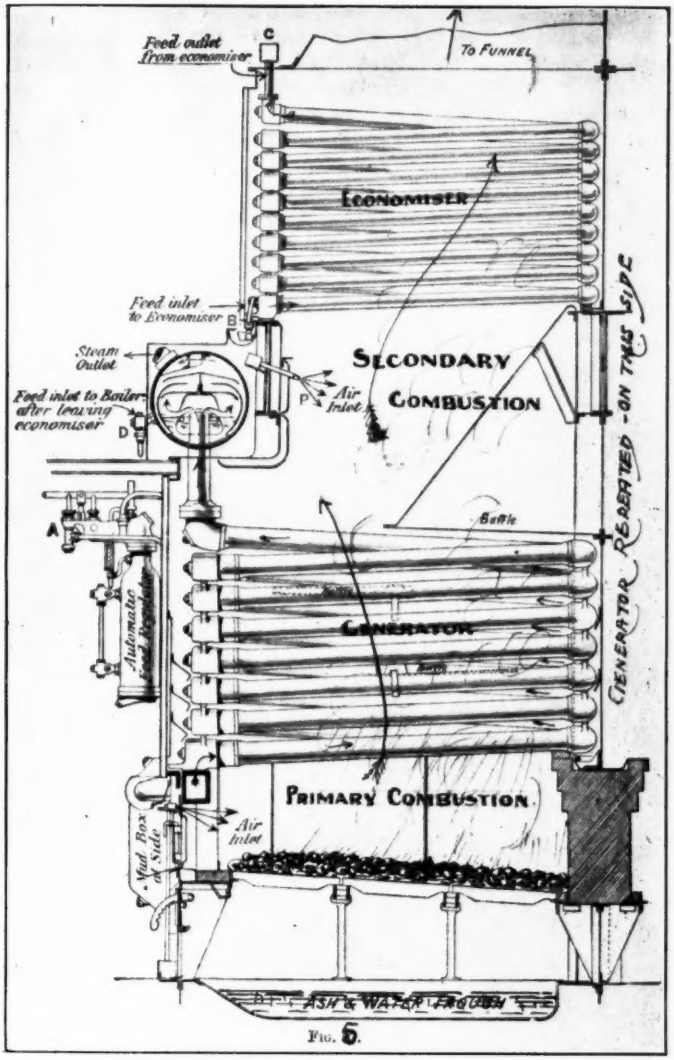
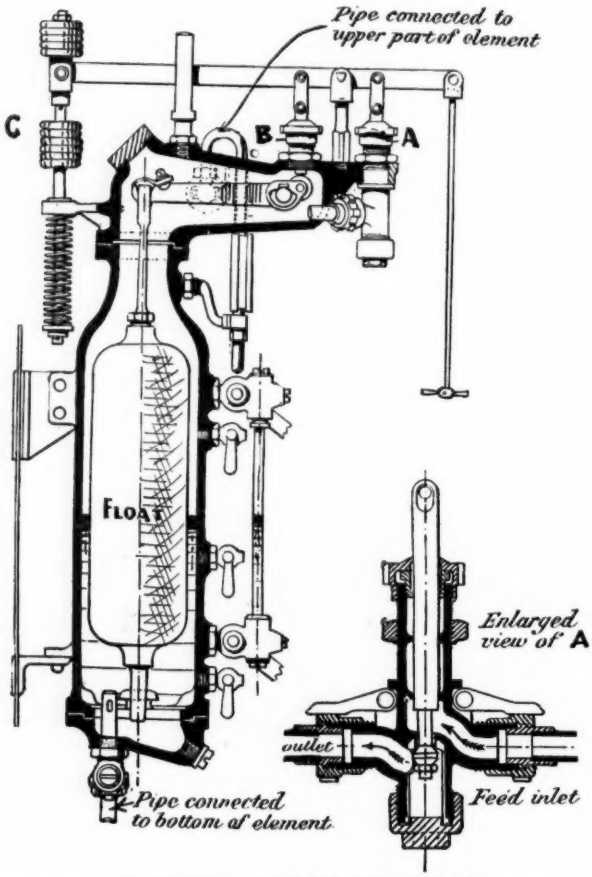


Fig. 5.

STRUCTURAL ARRANGEMENT OF ECONOMISER TYPE BELLEVILLE BOILER.

The arrows show the cycle of circulation.



THE BELLEVILLE AUTOMATIC FEED REGULATOR.

The rise or fall of the float acts upon the system of levers through the stuffing-box at B to permit the weights at C to open or close the valve A. When the water level falls the valve is opened, and when the valve closes the excess water is returned to the feed tank. The whole is attached to the column leading to the feed collector.

which it cannot hold either the lime or magnesian salts in solution; by the time it has reached the sediment collector, when the deposition or precipitation actually culminates, the grease and salt contents are deposited in a more or less non-adherent form. In order to accelerate the deposition of the grease or lubricants that may be present in the feed water a simple system of induced precipitation is employed.

The precautionary separating arrangements described are effective for meeting the evils following the introduction of a certain proportion of sea water owing to defective tubular surface condensers, but under these conditions extra surveillance is necessary. If the condensers were properly designed and constructed sea-water leakage should never occur; it is expected that the general adoption of the water-tube boiler will bring about the much-desired improvement in tubular-surface-condenser design.

With all water-tube boilers, the maintenance of a steady water level is very desirable, if not imperative; Mr. Belleville has recognised this and has equipped his boiler with an automatic feed-water device intended to deliver the feed water in such proportions as to maintain as nearly as practicable a constant hydraulic level. The steam and water ejected from the different elements into the drum collector are there separated, but in order to produce perfectly dry steam Mr. Belleville with considerable ingenuity provides an arrangement of baffler plates.

Actual results have repeatedly proved the low heat-utilisation efficiency of the old or non-economiser type of Belleville boiler when using fuel containing hydrocarbons and under conditions of forced draft. This fact has been recognised by the inventor, and the economiser type has been designed to increase the heat-utilisation efficiency and to a certain extent has effected this object. This type has been applied to the latest-built British warships, including the sister ships Powerful and Terrible, both having a Belleville equipment intended to develop 25,000 indicated horse power.

It will be seen in the figure (page 333) that a nest of economiser pipes is superposed some five feet over the ordinary generator, the dimension representing the height of a second combustion chamber which is fed with powerful jets of air, so that the unoxidised gases ascending from the grate are burnt, part of the resultant heat being absorbed by the nest of economiser pipes and heating the feed water flowing through them. The economiser elements are accessible for cleaning purposes; their pipes are smaller than those of the generator. The modifications in the feed-water arrangements involved by the introduction of the economiser are simple. In the tables of evaporation, given further on, the improvements in evaporative effect resulting from the addition of the economiser are defined.

The evolution of the Belleville generator has involved the introduction of important accessory equipments which have added considerably to its complication, and the necessity of the highest character of

workmanship and material is obvious. Before referring to the more salient defects that have been recorded by the British Admiralty as being associated with the Belleville boiler, the obvious truism must be repeated that an invention, however excellent, may be ruined by bad structural arrangements, materials and workmanship. One wonders whether foreign navies have had the same unenviable experience that has fallen to the lot of the British Admiralty.* It is only scant justice to M. Belleville to point out that much of the prejudice against his generator was the result of the employment, in the early examples applied to the British navy, of simply welded instead of solid cold-drawn tubes. The salient defects of the Belleville boiler are:

1:—The use of welded tubes.

2:—The constructional arrangements for supporting the rear or back-end joints of the tubes are defective; contractive effects, following those of expansion, have resulted in the tubes leaving the rear-joint connecting boxes, which should be arranged so that they should have free play for expansion and also be well protected from flame effect.

3:—The line of direction for the circulation is broken too abruptly by the rear connection.

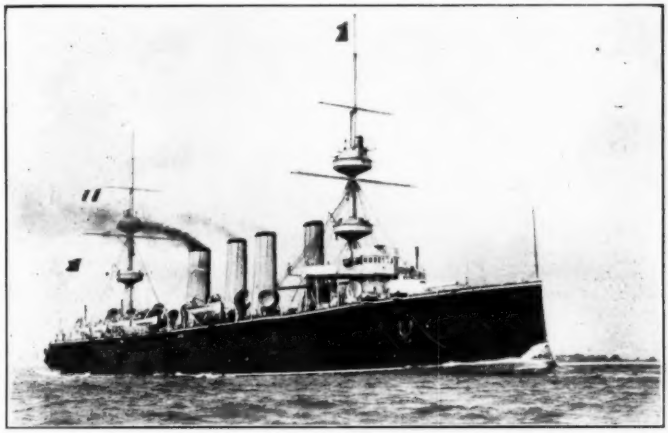
4:—The front conical connection with the collector is imperfect; the tendency of the associated tubes when expanding will be to prise open the conical joint.

5:—The angle of inclination of the tubes too nearly approaches the horizontal, and this tends to induce incrustation.

6:—The very elaborate arrangements for preventing lime, magnesia and grease from entering the tubes, prove that in this boiler reliance for clearance of these deposits cannot be placed upon the circulation effects. This defect would be lessened if the water circulation was more rapid; however, the internal galvanising of the tubes will greatly retard this destructive influence.

7:—Neither the fire doors or the smoke-box doors are made with sufficient care and rigidity to remain tight fitting when subject to rather violent alterations of temperature. The leaking smoke-box door will always prove prejudicial to the character of combustion; the smallest fractures allowing air to enter into chimney or funnel flue will seriously reduce its aspiration efficiency; further, the fire doors and

* The French cruiser Guichen, equipped with Belleville boilers, maintained an average speed of 16 knots in her recent trip from Brest to Saigon. On the other side, *The Engineer*, London, July 6, 1900, states that the British ship Highflyer broke down ignominiously; the Diadem had a disastrous voyage; the Skate torpedo boat was very nearly lost on her voyage to the Mediterranean; all these war-ships (British) had Belleville boilers.

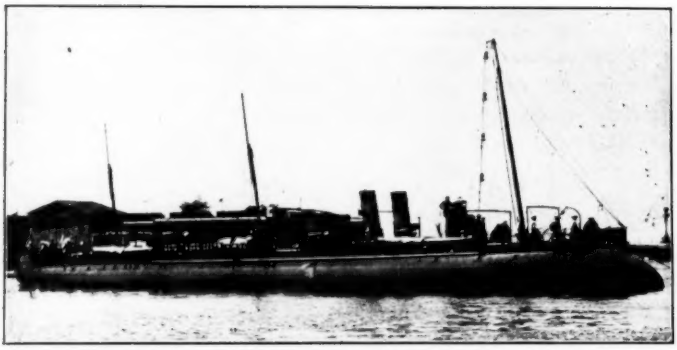


H. M. S. POWERFUL, STEAMING 18 KNOTS; BELLEVILLE BOILERS.

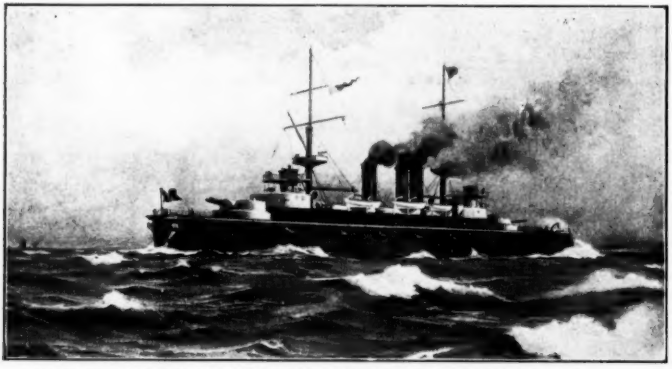
ash-pit doors should be so contrived that even if accidentally partly open they will automatically close in the event of a tube bursting.

8:—Delicacy of accessory machinery. The Belleville feed regulator is most ingeniously contrived, but whether its structural character is suitable for everyday wear on board ship is at least questionable. All the spindles and actuating gearing of feed regulator and non-return valve should be formed of unoxidisable metal.

FRENCH BATTLE-SHIP MARCEAU, NICLAUSSE BOILERS OF 12,000 INDICATED HORSE POWER.



FRENCH TORPEDO BOAT TÉMÉRAIRE, EQUIPPED WITH NICLAUSSE BOILERS, WHICH UNDERWENT A MOST SATISFACTORY 10-HOURS' TEST.



ARMOURED BATTLE-SHIP REGINA MARGHERITA, OF THE ITALIAN NAVY. 19,000 INDICATED HORSE POWER, NICLAUSSE BOILERS.

RUSSIAN CRUISER VARIAG, RECENTLY COMPLETED AT CRAMPS'. 20,000 INDICATED HORSE POWER, NICLAUSSE WATER-TUBE BOILERS.

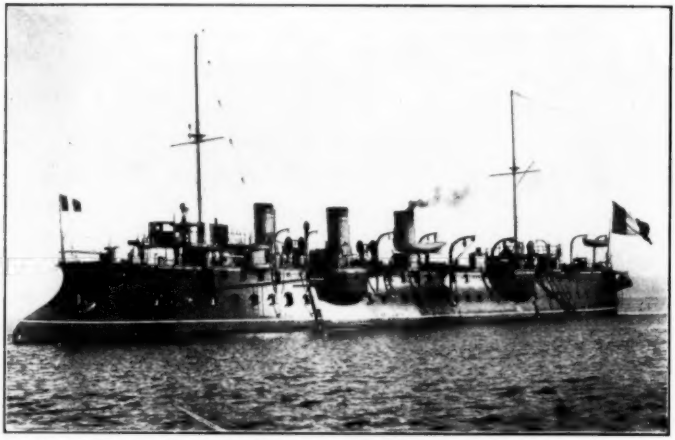
It is reported that her very successful trials have led the Russian Government to place orders for five more war-ships with American builders.

H. M. S. SEA GULL, FITTED WITH NICLAUSSE BOILERS

9:—Combustion arrangements. The space provided for primary combustion is inadequate, and until this serious defect is remedied the Belleville boiler will never be satisfactorily efficient in its heat utilisation, and will be unfitted for even a moderate degree of forced draft. The space provided for secondary combustion is satisfactory, but the method of introducing secondary air should give better distribution.*

* Abstracts from British Admiralty list of Belleville-boiler defects and proposed remedies.

Defects.	*Precautions.*
1. Burstings and overheating of tubes occurred in the Powerful, Terrible, Arrogant, Furious, and Hermes. Stated causes	The use of the highest character solid-drawn tubes.



CRUISER FRIANT, OF THE FRENCH NAVY, ON WHICH SEVERE TESTS OF THE NICLAUSSE BOILER WERE CARRIED OUT WITH MOST SATISFACTORY RESULTS.

The Niclausse Boiler. M. Niclausse has deviated from the ordinary track in his design—indeed, the Niclausse form may not be inaptly termed a combination of the small- and large-tube type, because by his duplex concentric-tube arrangement he secures to a considerable extent the erosive and scouring effect of rapid circulation—the conspicuous and valuable feature of the small-water-tube boiler. Ni-

various, most important being defects in manufacture of solid-drawn tubes and the accidental incursion of sea water.

2. Pitting of tubes. Occurred to a considerable extent in the Diadem; cause, acidity of water. — Galvanising the tubes internally and the use of zinc rods; acidity of water to be neutralised by introduction of lime.

3. Nickel washers leaking; this was the cause of very numerous leakages; cause, burning away of rear or back-end tube connections. — None suggested.

4. Over-heating of tubes through imperfect circulation. — None suggested.

5. Leakage of door joints, especially reported in the case of the Argonaut; cause, doors not being interchangeable; unsuitable asbestos washers employed. — Better quality of asbestos washers.

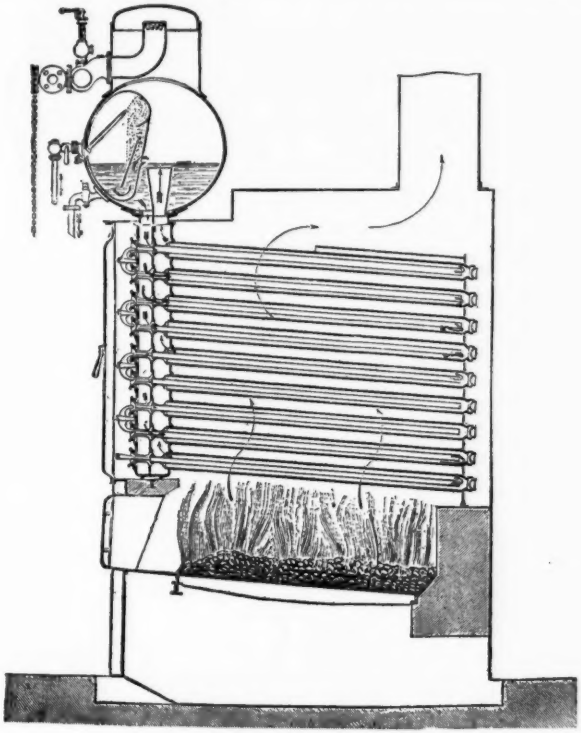
6. Smoke-box doors leaking. — Better and stiffer construction and smaller dimensions.

7. Back-end tube supports burning away occurred in some cases; cause, defective brick-work. — Better brick-work.

8. Leaky safety valves frequent source of trouble; cause, the cutting of the valve seats by the scale blown out of the drum-collector baffler plates, which are very liable to oxidation. — Galvanising of the baffler plates of the drum collector.

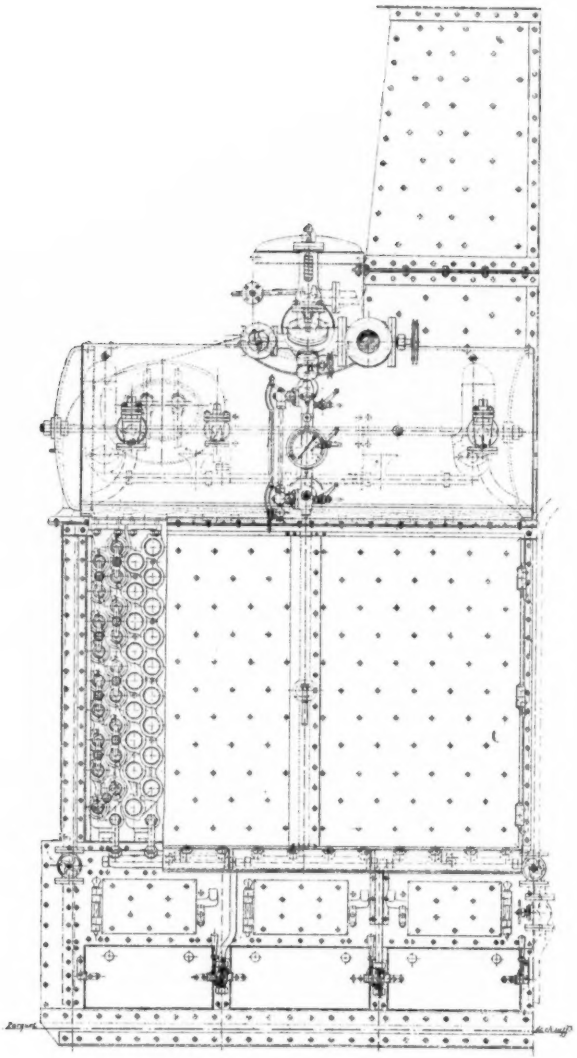
clausse has also adopted a steeper angle for his generator tubes, and he provides a rather larger cubic capacity for combustion over his grates; but in my opinion this might be greatly increased.

The figures, pp. 341-342, show the structural characteristics of this generator. It will be noticed that through the axis centre of the ordinary large inclined generator tube there is set another, and of course smaller, tube; the two concentric tubes are so connected to the front end that the cold feed water is introduced into this central tube, flows to the rear end, and then returns through the annular space formed between the two tubes. A partition in the front distributing box or



NICLAUSSE WATER-TUBE BOILER.

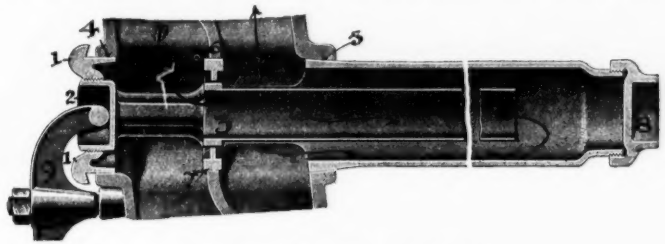
header effectually separates the introduced and down-flowing cold feed water from mixing with the hot water and steam. Page 342 shows the disposition of two groups of elements; it will be noticed that the



DISPOSITION OF TWO NICLAUSSE GROUPS OR ELEMENTS

tubes are in direct vertical relationship with one another from top to bottom, each vertical group having its header chamber which is connected to the drum collector; this drum is provided with a diaphragm for separating the descending feed-water currents from the ascending ones of hot water and steam.

The method adopted by M. Niclausse for attaching the concentric tubes to their headers is in the highest degree ingenious, simple, and unique, and gives this generator a valuable advantage in comparison with certain others. This system of tube attachment, clearly shewn

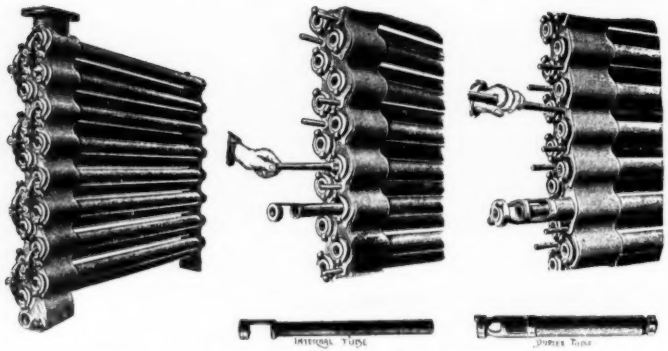


THE NICLAUSSE DUPLEX-TUBE SYSTEM.

The front end of the tube is formed into a taper sleeve which can be forced tightly into the header, and is cut away to allow the free passage of the water. The front part of the inside sleeve of the inner tube is screwed into the sleeve of the outside tube and closes its front end so that the two tubes can be withdrawn either together or separately. The water flows down the inner tube and returns back through the annular space between the tubes together with the generated steam. The tubes being held at one end only, are entirely free from expansion and contraction strains.

above, consists in the use of conical terminals and surfaces fitting coned apertures provided in the headers, the pressure necessary to maintain contact of the cone surfaces being secured by externally placed dogs. Although the Niclausse type of boiler has been extensively applied to marine work, the conical joints have been remarkably successful. The conspicuous feature of this duplex-cone arrangement is the rapidity with which it permits the replacing of a suspected tube.

The time occupied to effect the change of a tube when the generator is cold is one of a few minutes. This fact has been repeatedly demonstrated in the French navy, on the cruisers Téméraire, Fleurus, and Friant, as well as on the British naval vessel Sea Gull, on which a boiler working under full steam was isolated, its fires drawn, the water run off, the tube drawn and replaced ready for steam raising in 25 minutes. During a naval engagement this advantage of rapid tube renewal would be valuable beyond measure. The tubes all being interchangeable, the lower tubes, which are next to the grate and con-



SHOWING RESPECTIVELY A TUBE ELEMENT COMPLETE, REMOVAL OF AN INTERNAL TUBE, AND REMOVAL OF A COMPLETE DUPLEX TUBE.

sequently subjected to the greatest stress, can be replaced with the upper tubes, to great economic advantage. In the event of the fracture of a tube the sectional arrangement of grouping the tubes reduces the amount of steam and water ejected into the stoke hole.

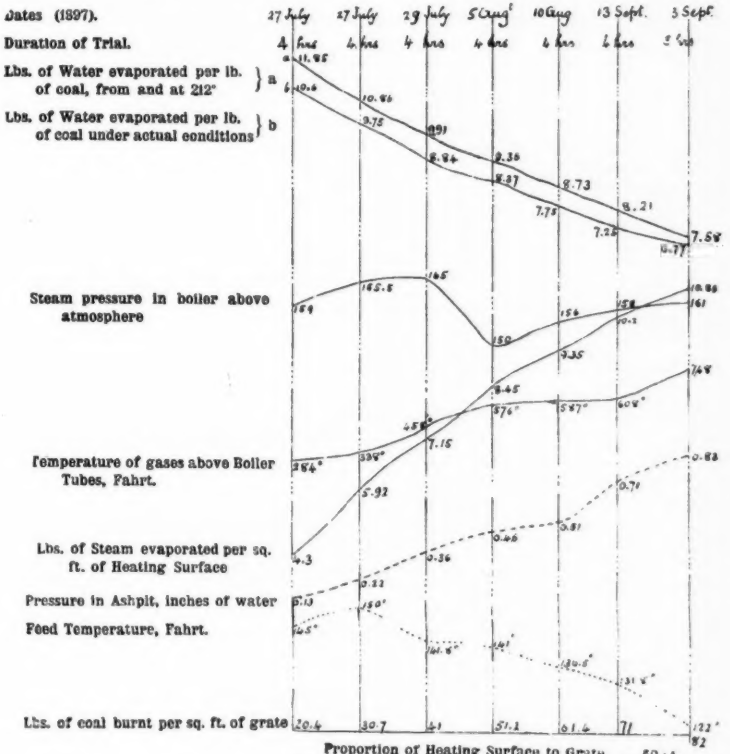
The circulating arrangements of the Niclausse generator, the direction of the currents of which is shewn on pages 341 and 343 by arrows, are all but perfect; the abrupt returns at the end of inner tubes and in the circulating chamber are the only objectional features. The inventor can claim, however, that the difficulty of examining, removing, and replacing the small tubes if the small-water-tube type is a defect that more than offsets the gain due to the generally satisfactory circulating arrangements of that type; he is perfectly justified in arguing that the circulating arrangements of the Niclausse generator are really very satisfactory, from the remarkable results obtained—for instance, those of the French torpedo boat Téméraire.

In this vessel no less than 84 pounds of coal were burnt per square foot of grate surface, and for ten consecutive hours, and this under the official supervision of officers of the French Government. The larger tubes, which were 4 inches in diameter, were not in the least deformed—a crucial proof of circulation excellence.

The absolute separation of the descending currents of cold feed water and ascending currents of hot water and steam is effected by the dividing partition in the collector header of each tube group, clearly shown on page 343. The steam and hot water ascend without appreciable resistance to the collector drum. In the Niclausse arrangement there is little probability that water will be carried from the drum into the steam pipe and to the engine cylinder. The possi-

bility of such an occurrence in any type of boiler should at once condemn it. Another characteristic is the absence of most of the auxiliaries which constitute such a conspicuous feature of the Belleville boiler; less detailed or skilled attention is therefore required in the Niclausse type. Firemen strange to the Niclausse boiler have no difficulty, it is asserted, in maintaining the full steam output. I consider, however, that the accident on the Italian cruiser Garibaldi justifies the provision of some simple and practicable form of automatic feed.

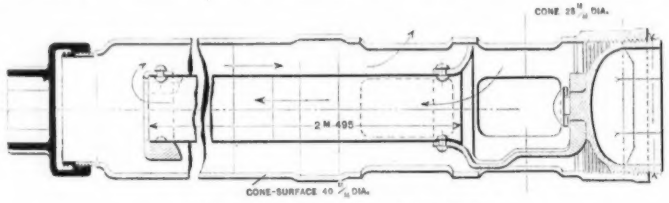
The question of the comparative evaporative value of the various tubes in different superposed positions above the fire grate is of great importance, and experiments made by M. Niclausse have determined the ratio between the several rows under varying conditions of forced



Proportion of Heating Surface to Grate .. 50 : 1.
The weight of Boiler per sq. ft. of Heating Surface, 10·85 lbs.

TESTS OF NICLAUSSE BOILER, TORPEDO-BOAT TYPE.

blast. The results, which are graphically illustrated on this page, are here given; it will be obvious that they bear upon the question of the advisability of employing an economiser if the combustion over the



IMPROVED NICLAUSSE TUBE ARRANGEMENT.

The sleeve is made in one piece with the large tube, the whole being made of mild steel, gaps being cut to provide for the flow of water. The inner tube is attached to the inside of the cap of the large tube, one cap serving for both tubes.

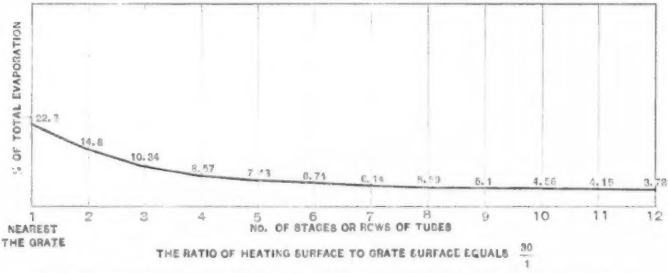
grate is perfect. In the tests, a special generator of 12 stages of tubes was employed, each stage being fed with water and also delivering its water independently.

The first row of tubes nearest the firegrate evaporated .....25 per cent. of the total.

The first three rows of tubes, having a heating surface of 7.5 square feet for each square foot of grate surface, evaporated.....50 per cent. of the total.

The first six rows of tubes evaporated.....66 per cent. of the total.

The top row of tubes evaporated only..... 3¾ per cent. of the total.

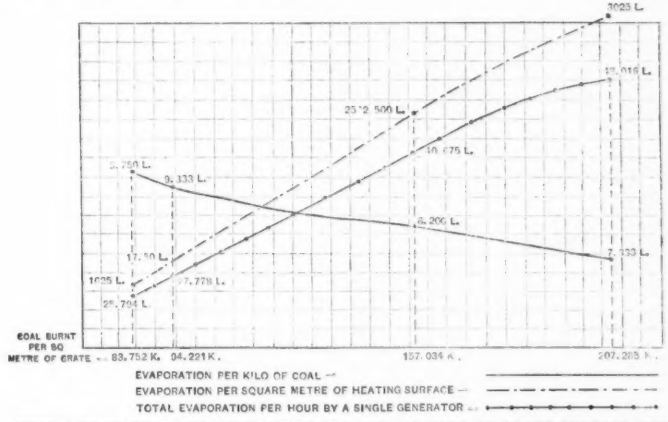


GRAPHIC REPRESENTATION OF THE COMPARATIVE EVAPORATIVE VALUE OF VARIOUS ROWS OF NICLAUSSE TUBES

The important fact ascertained from these interesting experiments is that with grate-surface rates of combustion varying from 10 pounds to the square foot of grate up to 61 pounds, the proportionate evaporation was almost exactly the same for each variation.

The Niclausse generator of the French battleship Friant was in 1898 subjected to a crucial test which it is just should be briefly men-

tioned here. During the naval manœuvres two years ago the minister of marine suddenly and without the least preliminary notice, ordered the Friant, although it had just returned from a three-years' period of active service, to take part in the naval evolutions and undergo as a preliminary a continuous run of a duration of six days and nights at a speed of 16 knots, and to finish off with an additional run of 17 knots, and then to be subjected to a close structural examination. After the



EFFECT OF INCREASE OF COMBUSTION PER SQUARE FOOT OF GRATE SURFACE UPON THE EVAPORATIVE EFFICIENCY OF A NICLAUSSE BOILER. RÉSUMÉ OF FRENCH OFFICIAL TESTS.

evolutions the tubes were tested with a straight edge and found true, no signs of deterioration exhibiting themselves; the result of the test was considered entirely satisfactory.*

The following modifications of the Niclausse boiler might be suggested:

1:—The combustion space—height from grate to first row of tubes—might with advantage be enlarged, especially if coal containing a notable percentage of hydrocarbons is used. A secondary air supply over the fuel in the grate might with advantage be added.

2:—A simple form of automatic feed might supplement the firemen's personal attention in securing a regular feed-water level.

3:—The replacement of malleable iron with mild steel is advisable, and is to be adopted.

* The Russian cruiser Variag, built by the Cramps, is equipped with 30 Niclausse boilers divided into four groups; the total number of tube elements is 426, each one having 32 tubes 2 m. 20 long and having a bore diameter of 82 mm. The official test gave a true maximum speed of 24.6 knots. In a continuous run of 7½ hours with natural draft the speed was equal to 20.3 knots.

4:—No special provision is made for the accidental incursion of sea water. The makers no doubt think it is unadvisable to load their generator with auxiliary apparatus to meet conditions such as the incursion of sea water, which should not be allowed to exist under any circumstances.

The Dürr Water-Tube Boiler. The German naval authorities have adopted the Dürr boiler for several of their battle-ships and cruisers, including the armoured cruiser Prinz Heinrich, now building, the battle-ship Baden, 6,000 indicated horse power, the Bayern, 6,000 indicated horse power, the protected cruiser Vinetia, 10,000 indicated horse power, and the protected cruiser Victoria Louise, 10,000 indicated horse power.

Apparently Herr Dürr, in the design for the main feature of his generator, the duplex tubes (misnamed by some Fields tubes), has drawn a feather from the quiver of Niclausse; indeed, a description of the Niclausse broadly covers the Dürr type, but there are considerable differences in detail; for instance, Herr Dürr inclines his duplex generator tubes from right to left, reversing the Niclausse inclination—see page 349. Again, instead of vertically grouping or sectionalising his duplex tubes in pairs, like Niclausse, to form elements, he builds up a single-front steel-box collector and distributor which he divides vertically into two halves, as shewn on page 349, by a central division plate, into which he introduces all the tubes; the front connector box is stiffened by stay bolts as shewn. Another innovation, and one of a decidedly ingenious character, is the employment of a duplex tube to effect the superheating of the steam: this duplex tube, as shewn in the figure, projects from the steam drum.

Herr Dürr's last iron-gridded and inclined iron back plate to support the rear ends of his tubes is arranged to allow them to have free and unrestricted play for contraction and expansion. In the absence of structural details little further reference can be made to this modified Niclausse—the Dürr steam generator.

One obvious objection to bringing all his tubes into one single col-

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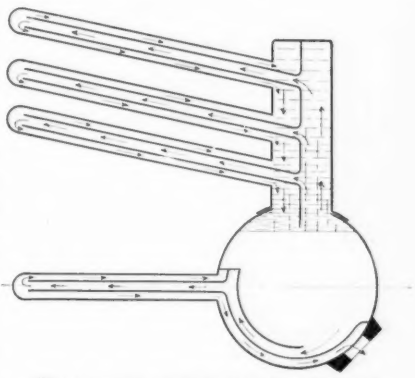
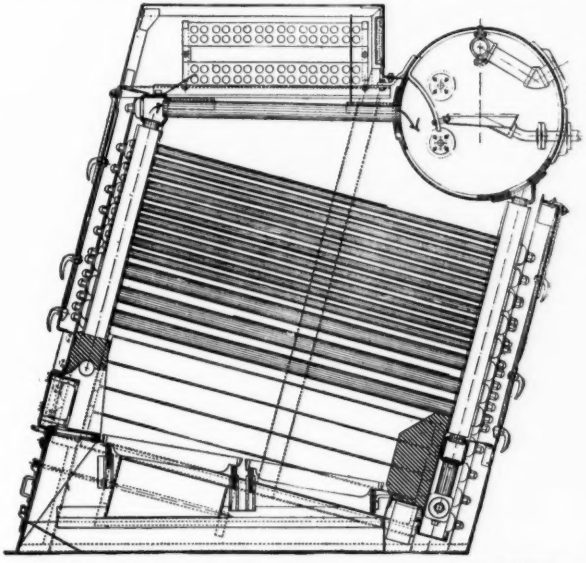
The Niclausse has been adopted for two of the British cruisers of the first class of the type of the Monmouth, 22,000 indicated horse power. France has adopted the Niclausse in he battle-ship Marceau, 12,000 indicated horse power. She has building the battle-ships Suffren and Henri IV., the former 16,200 and the latter 11,200 indicated horse power, the armoured cruisers Condé and Gloire, both of 20,500 indicated horse power, and the Gueydon, 19,600 indicated horse power. Russia is building the battle-ship Retvizan, 17,000 indicated horse power and the Variag, just completed, is a protected cruiser of 20,000 indicated horse power. Italy has just completed her armoured cruiser Garibaldi, 13,500 indicated horse power, and is building a battle-ship, the Regina Margherita, 19,000 indicated horse power. The United States have adopted the Niclausse for the new battle-ship Maine, 16,000 indicated horse power.

lector is that, in the event of a tube bursting, all the water and steam contents would be ejected on to the fire and this would mean a serious disaster. Besides, if the density of the water through the admission of impure feed is allowed to become too high, there will be a deposit in the box collector not so easy to remove. Herr Dürr has been very successful in building for stationary services a type of boiler somewhat on the lines of the Babcock & Wilcox, but with the addition of a horizontal small-pipe superheater, superposed over the main steam generator on the chimney-flue connection. Some of the dimensional details of the Dürr marine type of boiler are given further on in the tables of comparative efficiency.



DÜRR DUPLEX GENERATOR TUBES, SHOWING CENTRAL DIVISION PLATE.

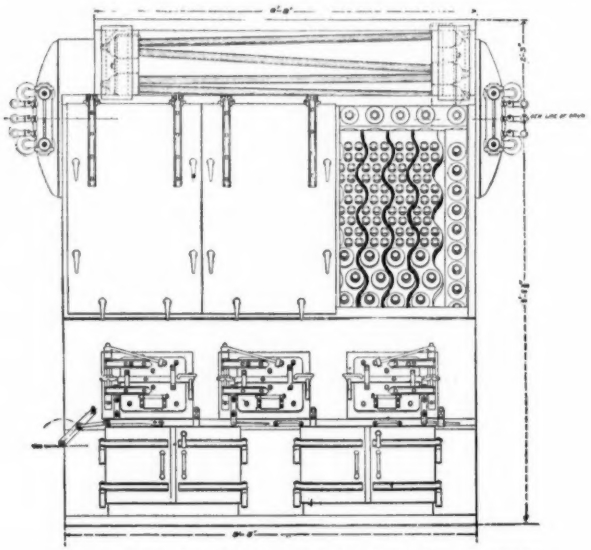


SECTIONAL ELEVATION BABCOCK & WILCOX WATER-TUBE BOILER.

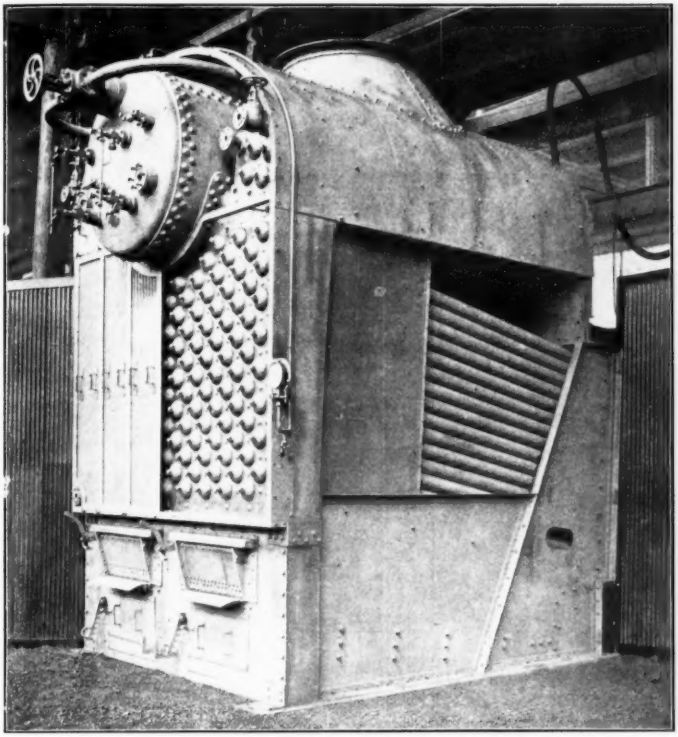
The Babcock & Wilcox Boiler. Although credit has been given to M. Belleville for his pioneer work in introducing the large-water-tube boiler into the French navy, it should not be overlooked that much of the confidence in the water-tube boiler, as distinct from the shell type, has been won from prejudice by American engineers, to whom we are indebted for the Babcock & Wilcox and the Root water-tube boilers. The introduction of the Babcock & Wilcox must have been made considerably over quarter of a century ago, and since then this type of boiler has been applied to the extent of hundreds of thousands of horse power for stationary or land purposes. The application of a modification of this type for naval purposes is quite modern and is therefore limited.

I will confine myself to the description of the application of the system on the United States gun-boat Marietta, that constituting the advanced stage in the evolution of the system. The general design will be understood by reference to page 349 and the cut below.

The straight generator tubes, single, like the Belleville, are connected to wrought-steel front and rear headers. The shape of the headers is square in section, elongated in a sinuous form and constituting a water collector for a group of tubes or elements. Openings



FRONT ELEVATION, BABCOCK & WILCOX WATER-TUBE BOILER.



DÜRR WATER-TUBE BOILER WITH PART OF CASING REMOVED.

are provided in the collectors or headers opposite the ends of each to permit of their internal examination. The angle of inclination of the tubes is 1 in 4. The tubes are expanded by means of ordinary roller expanders into the headers, and in this respect are at a disadvantage compared with the Niclausse and its conical tube connections, because the removal and renewal, unless it is effected by a skilled artizan, will occupy considerable time.

The front and rear headers are connected to the steam drum, the former by a short and the latter by a longer length of pipe. The steam drum defines the working level of the water, being maintained half full. The direction of the circulation of the currents of hot water and steam is indicated by arrows. The superposed-economiser practice of the Belleville finds its counterpart in this design in the installation of a

group of small feed-water pipes superposed over the main generator, through which the feed water is pumped.

The Marietta has performed satisfactory trips, one of which involved a voyage of 11,000 miles, from San Francisco to Key West. This was done at 13 knots, one knot over the contract speed. During this voyage it is stated that it was never found necessary to slow up for boiler repairs, and that at the end of the trip the generators were practically as perfect as at the commencement of the voyage.*

Small-Water-Tube Steam Generators. In the small-tube type of steam generators the lines laid down by theory to obtain first, a perfect cycle of circulation; second, a high velocity of the circulating currents; third, satisfactory provision for the effects of expansion and contraction, and fourth, a high degree of heat-utilisation efficiency, are more closely followed.

For example, the cycle of circulation is more direct. The small generator tubes, in the later designs, are approximately vertical and there are fewer abrupt bends or diversions to upset the motion of the circulating water. They are so devised that they can freely expand and contract without breaking the end joints.

The circulating effect is so considerable as to establish a more uniform temperature throughout the metallic structure of the steam generator. There is provided far greater cubic space for combustion effect than is common with the large-tube type, and there is better provision for the introduction in the combustion space over the grate of a well-distributed secondary air supply. The velocity of the water through the small tubes is such that the interior of the tubes is scoured, removing deposited matter that may be precipitated during intervals in steaming. It is of course understood that the water for

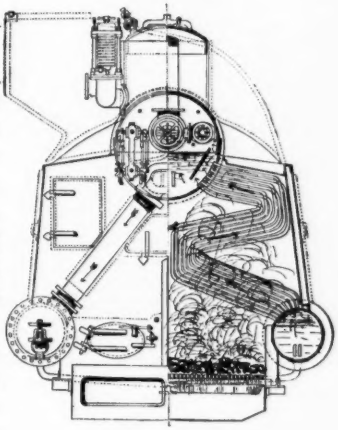
* In the Marietta Babcock & Wilcox boilers there are, as will be seen, two stages of tubes of different diameters. The first stage consists of three rows of tubes immediately above the fire-grate, 4 inches in diameter (6 B. W. G. thickness). The second stage consists of ten rows of tubes 2 inches diameter and 8 B. W. G. in thickness.

The tubular economiser fitted up in the up-take has 233 square feet of heating surface. The heating surface of the boiler is 1,810 square feet.

Length of generator	11 ft. 6 in.
Width	9 ft. 6 in.
Height over all	11 ft.
Total firegrate surface	95 sq. ft.
No. of 4-inch tubes in generators	57
No. of 2-inch tubes in generators	260
Length of tubes	7 ft. 6 in.
No. of 2-inch tubes in economiser	64
Length of 2-inch tubes in economiser	6 ft. 8 in.
Total weight dry	94,016 lbs.
Charged with water	112,016 lbs.

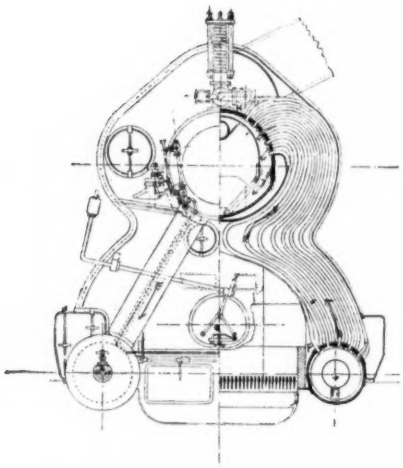
these small-tube generators is never allowed to attain any great density; otherwise it is easily conceivable that during periods of non-steaming the deposits might actually choke the small tubes. It is of the highest importance, if the best efficiency is desired, that the water should be as free as possible from depositable suspended matter.* In the earlier designs of the small-tube generator the tubes were not arranged in an easy curved, straight, or vertical line, and this is the defect that conspicuously characterised Du Temple's pioneer inventions. To John Thornycroft is due the merit of the innovation in design which included the use of more-nearly vertically arranged, if also curved, generator tubes.

The Du Temple Boiler. Commandant Du Temple's latest form of his generator is shewn below; he has unfortunately retained the zig-zag form in his generator tubes, with their abrupt curves and short, almost horizontal portions. This zig-zag form is structurally very defective. The small tubes are connected to the upper steam-and-water drum by joints formed of cones and nuts. The advantage claimed for this method of connection is its comparative facility for the rapid removal and replacement of the tube. The side or wing water-collecting vessels or barrels are provided with end covers permitting the lower portion only of the tubes to be examined and cleaned. The direction of the circulating water currents is clearly shewn by arrows; the down-comers are placed outside the main steam-generator structure and are of ample capacity and, owing to the lessened velocity of the water currents, promote the deposition of suspended matter. In one design of his steam generators the lower part of the generator tubes is made less in diameter than the upper part, the intention being to provide an increased area for the flow of the gases of combustion. The Du Temple steam generator has not been largely applied for naval purposes;



DU TEMPLE BOILER.

* It is obvious that owing to the small volume of the water space compared with that in shell generators (which contain 10 to 15 times as much water as the water-tube type) any impurity becomes concentrated very rapidly and this alone demonstrates the importance of pure water being always used.



THORNYCROFT'S EARLY DESIGN.

it has, however, been fitted to one of the British gunboats, the Spanker. Like many another inventor and pioneer, Commandant Du Temple has lived to see his invention—with modifications which it must be admitted are essential — applied on a grand scale. Du Temple's reward is one of honour rather than of ducats.

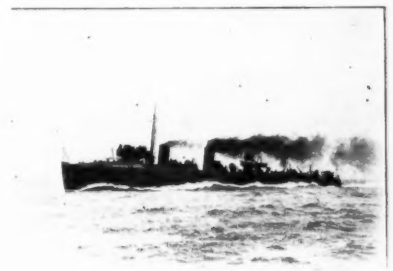
The Thornycroft Water-Tube Boiler. Although credit in generous terms has been given to Du Temple for his invention, it is due to John Thornycroft to say that but for his enterprise and his pioneer work in applying the small-water-tube boiler to marine purposes it is very questionable whether this type of steam generator would have obtained the importance it has.

The salient characteristics of Thornycroft's steam generator are, first, the curvilinear form of the tubes (modification of the Du Temple), providing for linear dilation, and second, his method of delivering the water and steam from the generator tubes into the steam space *above* the surface of the water in the steam-and-water drum. By this latter striking divergence from Du Temple's practice, Thornycroft secured the maintenance of his cycle of circulation, as there is no possibility of the water's returning through any other than the return or down-comer tubes provided for this purpose.

Above is shewn Thornycroft's early design. The direction of the cycle of circulation of the water current is shewn by the full arrows. Like Du Temple, Thornycroft employed outside return or down-comer tubes, two large-diameter down-comer pipes being provided to lead the water from the upper steam-and-water drum to the side collecting vessels. Baffler plates fixed in the steam drum assist in separating the water from the steam ejected from the tubes. The steam pipe runs along the length of the drum or upper barrel.

A fairly generous allowance of space for combustion is provided

over the grate. In order to ensure that the gases of combustion are uniformly distributed over the generator tubes, the curves of the inner row of tubes on each nest are arranged in such a way that they gradually close upon each other just under the invert of the steam-and-water drum. The gases are consequently compelled to flow through the interspaces at the lower portion of the generator, instead of flowing directly through the interspaces at the upper part of tubes, which would be the result of equal interspacing. The arrangement of graduated interspacing obtains fair uniformity of heat distribution.



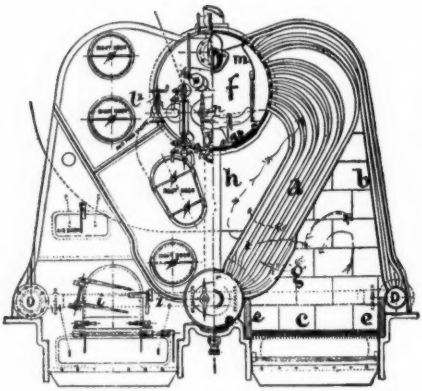
H. M. S. ALBATROSS.

JAPANESE DESTROYER SHINONOME.

It will be noted by the figure that Thornycroft provides a fire-guard plate fixed under the invert of the steam-and-water drum. The tubes forming the outside rows of generator tubes are brought close together so as to constitute a close wall. They open again at the top of the nest of tubes for the purpose of providing the necessary degree of interspace, and to permit the gases of combustion to escape to the chimney. The characteristic dimensions of the tubes used by Thornycroft are: External diameter, 1¼ inches: thickness, 0.128 inch: external diameter, 1⅛ inches; thickness, 0.104 inch.

The feed water flows into the centre of the steam-and-water drum.

H. M. S. BOXER; BRUISER ASTERN.



THORNYCROFT BOILER, DARING TYPE. CROSS SECTION.

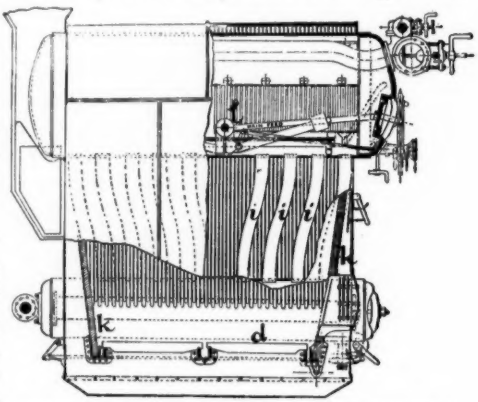
The Thornycroft boiler is covered in with light steel casings easily removable for repair and renovation.

The tests of this generator in the British ship Speedy tend to shew that the portions of the generator tubes above the water level in the steam-and-water drum or barrel have an abnormal tendency to corrode; this action is doubtless due to the influence of air along with the moisture from the wet steam. All surfaces intermittently exposed to water, or exposed to the effect of surface moisture, are liable to abnormal corrosive activity. In the Speedy the tubes had to be replaced in four years from the date of her commission.

Another feature of the lessons gleaned from the trial of the Speedy is the fact that the incursion of sea-water into the feed initiated the undesirable action of priming; the same effect would occur, of course, for the same reason, in other small-water-tube boilers.

The fuel-utilisation efficiency of Thornycroft's steam generator has been repeatedly determined with non-hydrocarbonaceous fuel, and the results, thanks to the adequate combustion space provided, can be considered satisfactory.

A decided innovation appears in a more recent design of this boiler which is known as the Daring type. The object in this new design was to obtain increased grate and



THORNYCROFT BOILER, DARING TYPE. LONGITUDINAL SECTION.

heating surface in a given cubic space. The Daring type is sectionally shewn on the opposite page. The chief characteristics differentiating it from the first design are conspicuously shewn. Instead of two collecting water vessels or barrels, there are three, of which the central one may be larger than those at the wings or sides, though in the latest designs all are of the same diameter. The side water vessels receive the terminals of the three rows of tubes constituting the outside walls of the steam generator. Two of the three rows of tubes constituting the side tubular walls actually touch each other. The two principal nests of generator tubes, right and left of the central collecting vessel, find their lower terminations in the central collecting vessel. These nests of tubes, owing to the disposition of their curved parts, provide what may constitute a secondary space for the combustion and distribution of the flow of the gases. The direction of flow of the gases follows the lines indicated by the dotted arrows, the closure and enlargement of the inter-tubular spaces preventing them from following any other direction. It will be seen that the sensible heat of the gases will be very considerably reduced by the time they have traversed the tubes in the direction indicated.

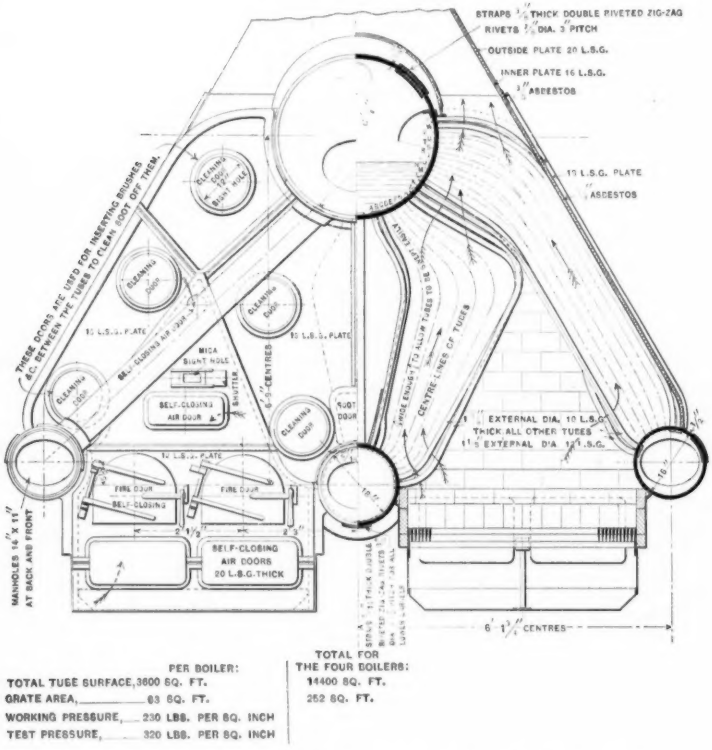
In this earliest of the Daring type of steam generator, Thornycroft has eliminated the outside down-comer return-flow pipes, employing instead a series of vertical pipes passing directly and centrally from the invert of steam-and-water drum to the central collecting vessel; this latter is connected to the small outside collecting vessels by means of horizontal pipes.

With coals containing an appreciable proportion of hydrocarbon in their constitution it is quite possible that the central space, acting as a secondary combustion chamber, might attain a higher temperature than the two side and primary combustion zones. Under such conditions the series of return pipes might possibly become heated to such an extent that the evaporation would tend to produce a disturbing effect on the cycle of circulation. Part of the water, instead of descending, would, by the bubbles of steam, be forced upwards to the steam-and-water drum. The culminating effect would be a tendency to produce the dangerous priming action.

The method of separating the steam and water differs from that in the original type.

In the latest modification of the Daring type the salient features of difference are the reintroduction of the outside down-comers or return pipes, whilst the series of centrally placed down-comer tubes are re-

tained; second, instead of the tube terminals being connected to the steam-and-water drum above the water level, one half of the tubular groups are attached above the normal level of the water and one half below, so that the latter are drowned. It is found that the surface of the water in the drum is of sufficient capacity to permit the steam to


STRAPS ⅜" THICK DOUBLE RIVETED ZIG-ZAG
RIVETS ⅞" DIA. 3" PITCH
OUTSIDE PLATE 20 L.S.G.
INNER PLATE 16 L.S.G.
½" ASBESTOS
10 L.S.G. PLATE
½" ASBESTOS
THESE DOORS ARE USED FOR INSERTING BRUSHES &C. BETWEEN THE TUBES TO CLEAN SOOT OFF THEM.
CLEANING DOOR
SIGHT HOLE
10 L.S.G. PLATE
MICA SIGHT HOLE
SELF-CLOSING AIR DOOR
6" C. CENTRES
SOOT DOOR
THESE ENDS CUT TO ALLOW TUBES TO BE CLOSE TO CENTRE LINES OF TUBES
EXTERNAL DIA. 10 L.S.G. THICK ALL OTHER TUBES
EXTERNAL DIA. 12 L.S.G.
FIRE DOOR
SELF-CLOSING
SELF-CLOSING AIR DOORS 20 L.S.G. THICK
MANHOLES 16" X 11" AT BACK AND FRONT
6' 1½" CENTRES

	PER BOILER:	TOTAL FOR THE FOUR BOILERS:
TOTAL TUBE SURFACE,	3600 SQ. FT.	14400 SQ. FT.
GRATE AREA,	63 SQ. FT.	252 SQ. FT.
WORKING PRESSURE,	230 LBS. PER SQ. INCH	
TEST PRESSURE,	320 LBS. PER SQ. INCH	

THORNYCROFT WATER-TUBE BOILER, DARING TYPE. THE LATEST FORM.

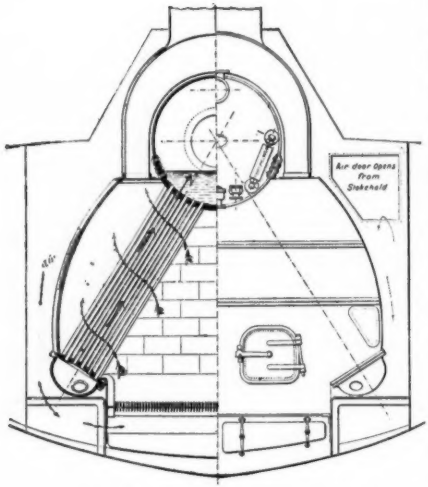
escape so slowly from the drowned groups of tubes that no priming effects are produced. If all the tubes were drowned, priming effects would tend to follow. By this new arrangement Thornycroft reduces the proportion of his tubes especially liable to abnormal oxidising effects because of their alternate exposure to steam and water influences.

The Yarrow Small-Water-Tube Boiler. The Yarrow type was introduced after Thornycroft had established the great value of this

particular type of water-tube steam generator for naval purposes. There is, however, a marked distinction between the Yarrow and the Thornycroft steam generators. For example, in the former the small generator tubes, 1 inch to 1⅛ inch external diameter, have all their upper terminations below the water level of the steam-and-water drum, and the tubes are thus what is technically termed "drowned" (p. 360). In the other type, as just described, the generator tubes are connected to the upper space above the water level of the steam-and-water drum.

THORNYCROFT BOILER, DARING TYPE, ERECTED AND CASED IN.

In the Yarrow, the steam-and-water drum (as in the Du Temple and Thornycroft steam generators), is placed over the centre of the grate, receiving the upper terminations of both nests of generators. The steam-generator tubes connecting the steam-and-water drum with the side or wing collector vessels at the foot of each nest of tubes are, as will be seen, straight. The side or wing collector vessels are half



YARROW SMALL WATER-TUBE BOILER.

round in section; the vessels are completed by an upper flat plate, placed at right angles to the tubes constituting the tube plate, and into which the tubes are expanded. The outside groups of the two groups of tubes serve as the down-comers or return tubes. No separate large down-comer pipes are provided, although in some instances Yarrow has provided stay tubes of larger diameters than the small generator tubes, which are made to act as return tubes. In order to separate more definitely the two ascending and descending currents of water when they reach the collector vessels, a diaphragm has been introduced which prevents the confusion of the currents.

The enclosing outside casings of the Yarrow steam generator are removable, either altogether or partially, and they permit easy access to all the steam-generator tubes. In order to reduce the loss by radiation, the side casings are internally lined with asbestos and the end casings with firebrick. Yarrow boilers have been installed in cruisers of the Dutch Government. One valuable feature of this generator is the ample space provided for primary combustion. The diameter of the small generator tubes varies from 1 inch to 1¼ inch.

The Normand Small-Water-Tube Boiler. This type combines the characteristic features of the Du Temple, the Thornycroft, and the Yarrow designs, along with certain other innovations more especially relating to the combustion arrangements. Mr. Normand has certainly approached the subject of designing an ideal boiler in a thoroughly scientific manner; he has analysed the various conditions that have to be satisfied, and his design is a declared attempt to meet them in as complete a manner as practicable.

The generator tubes are 1 inch internal and 1.3 inch external diameter. The form of the tubes is composite; some of them are practically straight, others are curved. The tubes enter the upper steam-

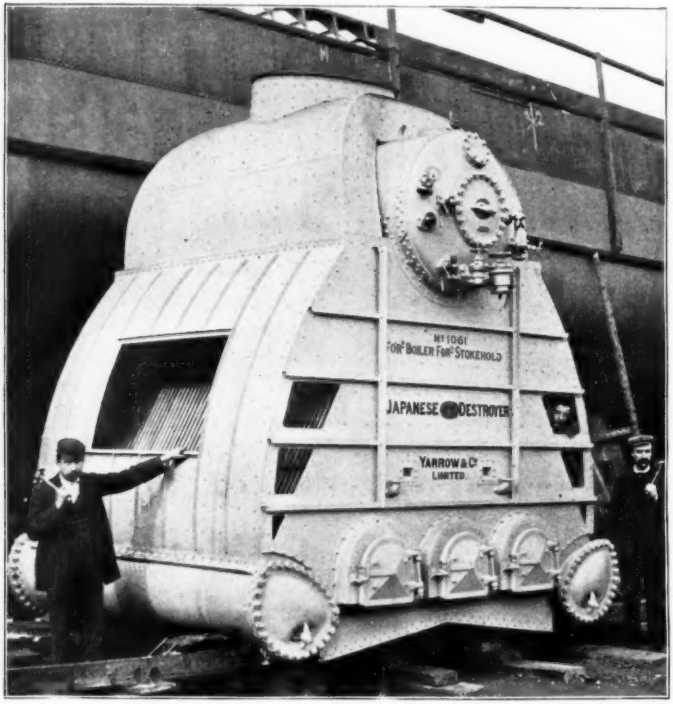
TABULATED DATA GIVING COMPARISONS BETWEEN TYPICAL SHELL BOILERS AND THOSE OF THE LARGE AND SMALL WATER-TUBE TYPE.

	Shell Generator. Martin type.	Shell Generator. Ellis & Eaves	Shell Generator Howdens.	Water-Tube Belleville.	Water-Tube Belleville.	Water-Tube Babcock & Wilcox.	Water-Tube Babcock & Wilcox.	Water-Tube Thornycroft.
Dimensions (Outside).....	15′2″ x 19′6″	14′9″ x 20′	13′9″ x 19′6″	.....	.....	.....	.....	.....
Number and Character of Steam Generator.....	4 double ended cylindrical.	4 double ended cylindrical.	4 double ended cylindrical.	12	18	10	12	8 single ended.
Character of Draft.....	INDUCED.	INDUCED.	FORCED.	FORCED.	NATURAL.	FORCED.	NATURAL.	.....
Heating Surface, Sq. Ft.....	20.000	20.000 (?)	15.460	21.000	31.500	27.000	32.400	28.000
Number of Sq. Ft. of Heating Surface, per ton of Boiler....	55.6	.....	50.4	140	150	135	131 8	266.6
Number of Tube Groups or Elements, Dimension of Tubes.....	.....	.....	.....	11 Elements Made up of 4″ tubes. Economiser tubes 2¾.	11 Elements. Made up of 4″ tubes. Economiser tubes 2¾.	.....	.....	.....
Area Grate Surface, Sq. Ft.	536	.....	436	633	950	615	738	480
Ratio of Heating Surface to Grate Surface.....	37/1	.....	35/1	33/1	49.1/1	44/1	44/1	58.4/1
Equipped with Economisers	No.	No.	No.	Yes.	Yes.	No.	No.	No.
Weight of Boiler in tons, dry Weight of Boiler in tons, with Water.....	359 518	410 550	267 399	150 172	206 238	200 266	246 325	105 122
Air Pressure under Grate, inches of water.....	1″—1½″	.....	1″—1½″	¾″	.....	1″—1½″	.....	1″—1¼″
Steam Pressure, lbs. per sq in.....	200	200	260	260	200	200	200	200
Consumption of Fuel (Coal) per I. H. P. in lbs. (16 lbs dry steam per I. H. P.)	1.96	1.61	1.33*	2.1	1.75	2.00	2.00	2.06
I H.P, developed per Sq. Ft. Grate Surface.....	18 65	18 63	22.91	15.8	10.52	16.26	13.5	20.62
I.H.P. per ton of Boiler (16 lbs dry steam per I.H P.)....	17.57	15.57	21.91	34.4	23.69	26.94	22.82	59.5
Ratio Heating Surface to I.H.P. developed.....	2/1	1/1	1.54/1	2.1/1	1.75/1	2.01/1	2.01/1	2.06/1

* There is probably an error here; the calorific value of steam coal would not permit such a result to be obtained in regular work every day.

and-water drum beneath the water level, as in the Yarrow design. The side or wing water collectors at the base of the tubes are cylindrical. The arrangement of external water-return or down-comer tubes is similar to Du Temple's design. There is no special arrangement provided for effecting the separation of the steam and water.

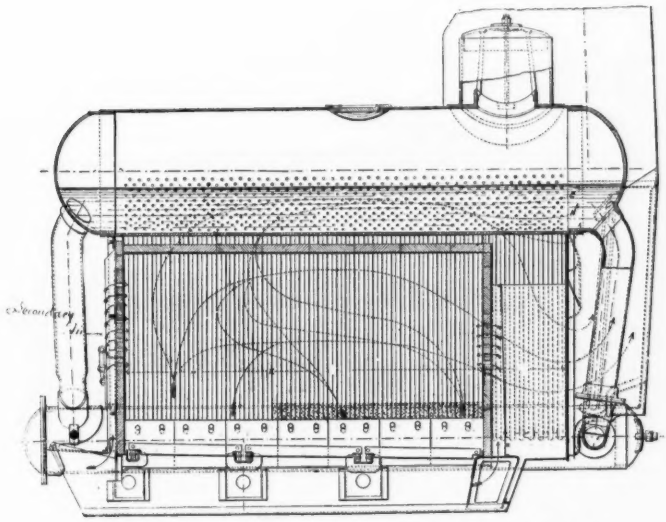
The gases of combustion follow the direction indicated by arrows drawn on the figure. The end walls of the combustion chamber are



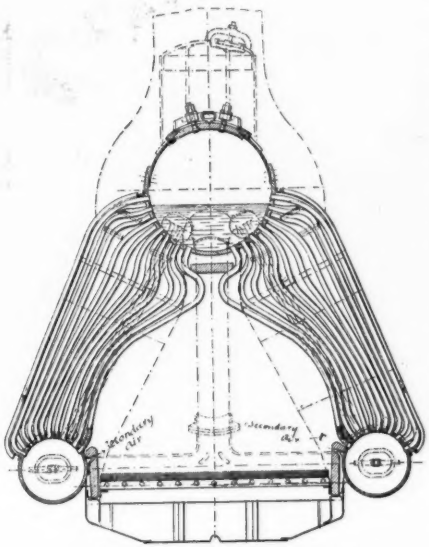
YARROW WATER-TUBE BOILER OF 1,600 HORSE POWER.

made with refractory tiles, and similar tiles supported by the generator tubes protect the inverted side of the steam-and-water drum from the direct effect of the flames. The flow of the gases of combustion is different from that in the other designs. The gases flow around the tubes and along the inside of each side casing to one of the ends of the generator, where they are directed to the funnel.

A secondary air supply is provided, air-inlet openings being pro-



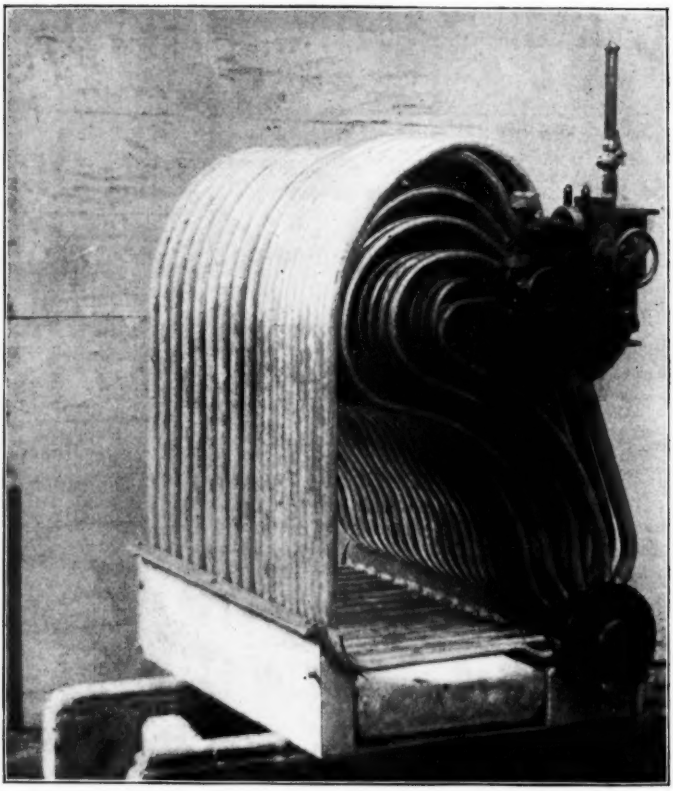
LONGITUDINAL SECTION, NORMAND SMALL WATER-TUBE BOILER.



CROSS-SECTION OF NORMAND BOILER

vided in the firebrick or refractory tiles along the grates. This secondary air supply was first invented and applied by the author, and fully described by him at the last Edinburgh meeting of the British Association.

This feature of the Normand steam generator is certainly praiseworthy, and by its aid M. Normand should have little difficulty in securing the perfect combustion of the hydrocarbon contents and in obtaining a high degree of thermal utilisation.



THORNYCROFT BOILER, LAUNCH TYPE, IN WHICH THE WATER TUBES SERVE AS GRATE BARS.

M. Normand also introduces air through the end walls, special apertures being provided for this purpose. An inverted refractory bridge pierced with apertures forces the gases to pass around the lower part of the generator tubes before passing to the funnel. Generous provision of space for combustion secures a satisfactory figure of evaporative efficiency.

THE EXPENSE ACCOUNT OF THE MACHINE-SHOP.

By H. L. Arnold.

IT would seem at first sight to be an easy matter to determine whether a given factory expenditure should be charged as a loss, or credited as a permanent gain to the business. When, however, all of the aspects of any factory operation are considered fully, it will be seen that there may be strong arguments for regarding some particular item or items of expenditure as either loss or gain, according to the angle of observation. This Janus-faced expenditure item is more likely to appear in the machine-shop than in the simpler manufacture of textiles and so on, where all material purchased has a certain pretty constant waste percentage, and all direct labor expended goes unequivocally to the production of salable merchandise. Precisely the same conditions occur in some classes of metal-working establishments. Generally speaking, it may be said that all cases of simple repetitive manufacture with variations which are but slight, or with no variations whatever, involve fewer doubtful items of outlay than do those factory operations which lead to the production of improved new things, although, when a close examination of certain items of textile-factory outlay is made, it will be seen that there are plausible arguments for charging them as permanent losses or unproductive expense, or for crediting them as permanent gains and highly valuable assets.

Take advertising expense, for instance. Obviously there can be no increase of salable factory product gained by money spent in advertising, hence advertising should be charged directly to expense; that is one view. A view which includes the probabilities of the future shows at once that past advertising extends and increases the probabilities of orders for the factory product in the future, since the recognition and good will of the purchasing public are certainly at the very head and front of valuable factory assets.

It is, however, more noticeably the case that accountants disagree in a very marked manner over the final disposition of large items of

Mr. Arnold, in this article, deals with probably the most important subject in machine-shop accounting—one, at least, whose misconception has the largest possibilities of disaster. The paper now presented is from the advance sheets of Mr. Arnold's comprehensive work, "The Complete Cost-Keeper," dealing with principles and systems of factory accounting and the aids thereto, published by THE ENGINEERING MAGAZINE Press, Nov., 1900.

factory expenditure where there are certain tangible factory residues left in possession of the factory after the completed finished product has been delivered to the customer and paid for by him.

Suppose, in the instance of a machine-tool factory, an order is received for a lathe of certain dimensions, and that because a lathe of that particular size has not been hitherto produced by this particular factory, or because the superintendent desires a better product, or for any other reason, the factory decides to fill this order with something different from anything it has before made. Similar cases arise constantly, and will continue to arise for a long time, perhaps forever, since it is never safe to say that the final best form of any machine product has been reached.

It having been decided to fill the lathe order with a new creation, the usual shop procedures are begun. First, the new lathe receives arduous and costly attention in the drawing room, involving the severest labor of the highest talent available, with a correspondingly large money expenditure, resulting in the production of the drawings requisite for the building of the improved lathe. Next the drawings go to the pattern-shop, and a costly set of patterns is produced for the use of the foundry, which finally furnishes a set of castings to the machine department, and the actual construction of the new lathe itself begins. The lathe is finished, delivered to the customer, is satisfactory and is paid for at contract price, and the establishment building this successful lathe has remaining in its possession the drawings and patterns therefor, which may have cost more than the whole price paid by the customer.

At this point of this transaction, the actual case is very possibly this: the lathe builder has paid out more money in producing the lathe than the customer has paid for it, and the whole matter involves a loss, if the drawings and patterns are charged to the expense account. If, however, the lathe drawings and patterns are credited as shop assets, the whole transaction shows a gain on the books, although more money has been paid out than has been paid in, and if an actual cash gain is to be had on the transaction it must come from future operations, involving the use of the costly drawings and patterns left in possession of the factory.

The questions arising from this simple example of filling the lathe order appear in connection with all factory equipment. At the time a new factory plant has been installed and before production and sales of product begin, the total investment represents, in point of fact, a total loss, and unquestionably should be charged directly to expense.

and this is in some cases done, and the whole cost of an extensive factory equipment, outside of the forced-sale-value estimate of the ground and factory buildings, is written into the expense account, thus making the concern a bankrupt on the face of its own accounting, or, if not a bankrupt, because of faith and yet unexpended capital in the hands of its projectors, a heavy debtor with no assets. This is the actual position of the new factory not yet in work, and if the factory accounting is based on the actual condition of time past and present, everything to date is an outlay with no return and must be written as a loss.

The expectation for the future is not an accomplished fact. It is a possibility, beyond any question, and a clear probability in the minds of those capitalists who have invested in the factory plant. It may even be said correctly to be as likely to produce profitable returns as any human effort can be, and yet the fact is that when the factory opens its doors to begin production its books must show simply an outlay with no return.

Going back to the lathe order: at a subsequent period we may find that the patterns and drawings have proved to be assets in constant profitable use; the lathe may have been found extremely suitable, and many duplicates may have been ordered, and the whole transaction at this period may show a large gain. On the other hand, the lathe may have met with only a special and rarely-occurring demand. There may have been few orders for duplication, or none at all, and the drawings and patterns, instead of being valuable assets in constant profit-producing use, may have been wholly unproductive, and even a source of more loss in the way of insurance and storage room.

Hence it is very clear that the factory accountant who deals with facts and conditions of the present moment only will write the lathe drawings and patterns into the expense account, and thus make the transaction of filling the original lathe order show a loss, while the factory accountant who has hope and faith in the future will write the lathe drawings into the factory assets, because of his reliance on probabilities. And both proceedings are correct, and no difference in the future profits or losses of the lathe builder is made by writing the drawing and pattern costs either way. But in the one case the accounts show a gain which has not accrued, while in the other case they show a loss which at some future time may be recouped; hence either accounting may be shown in the future to be faulty.

If the case of the lathe order is carried to the extreme, and the lathe builder continues to work only on new orders without duplication, he

must, of course, transform his cash in bank into unused drawings and patterns, and cease to do business when his original capital is exhausted; and precisely this condition of affairs has occurred many times where the operations of a machine factory were directed by a really skillful and able machine designer, whose every individual creation was an operative success, and who well and worthily sustained his high reputation as a mechanician.

In this lamentable and not infrequent case, the ingenious manager may fancy up to the last moment of open doors that he is in a prosperous financial condition, because his books show large gains in the way of shop equipment which are his very own. He says to himself: "All of these machines which I have produced have been good, have given satisfaction, and the drawings and patterns and special tools for their production must certainly be of great value, because they will enable me to produce future duplications at a large profit." But this ingenious and able machine designer has not the commercial instinct which leads him to devote his energies to the procurement of orders for repetitions of his work; on the contrary, the natural trend and bent of his mentality is to produce new things and ignore the successes of the past, and if left to himself, bankruptcy is much more probable than commercial gain.

The other extreme is found in the factory managed by the mind of purely commercial instincts—the mechanical mind and the commercial mind being as far asunder as the poles, both in their motives and methods of procedure. The man of mechanical mind conceives the idea of a real and valuable improvement, embodies it in usable form, scores an unqualified success, and washes his hands of the whole matter; he has unriddled the riddle, is satisfied with his effort, and either quits it and goes on with something else, some new problem seized by his active mind, or sees further improvements and refinements to be made, which may be mechanically correct, but do not add very much to the working value of his first achievement and so make no money. The commercial mind sees the money possibilities inherent in the new production of the mechanical mind, and gives its whole efforts to the securing of orders for duplications, declaring the present production to be not only the best thing that ever was, but the best thing that ever can be, and setting its face like a flint against any change, and so does secure orders for repetitions and makes money by advocating established practice.

The commercial mind and the mechanical mind are often associated as equal powers in factory management, and sometimes achieve

commercial success where thus associated on even terms. A money success is, however, much more likely to eventuate where the deciding authority lies with the commercial mind, while the mechanical mind is left at liberty to evolve new creations, being capitalized and supported by the sale of duplications of past successes, on orders secured by the efforts of the directing commercial mind.

If the accounting is directed by the purely commercial mind, the cost of developing new ideas is invariably charged into the expense account, because the commercial mind instinctively and naturally conforms to actual commercial conditions and fully realizes the possibility of forced sales with the factory doors closed.

A going concern has intangible assets in the way of good will and custom, which are undoubtedly of the very highest value so long as the business continues with open factory doors. At a forced sale these intangible assets become utterly valueless. They shrink to nothing and disappear as completely as if they had never existed, although they were the very life and breath of the business while it continued to be operative.

In the case of a forced sale, drawings, patterns, and special factory tools are found to be absolutely without buyers. The drawings are not worth so much as the rolls of blank paper on which they were made. The patterns are not worth so much as the lumber used in their construction cost, and the special shop tools and fixtures, so highly valued by the fine mechanical mind which produced them, will not sell for so much as would the iron in the pig and the steel in the bar of which they were made. Yet where the accounting is directed by the mechanical mind it will invariably be found that shop tools and appliances are carried in the accounting of assets, in greater or less degree. In some cases a certain proportion of the drawing, pattern, and special-tool costs is charged to expense, and a certain other portion is credited as an asset. Small tools up to certain sizes will be found in some cases charged to expense, while above this limit the costs of similar tools will be carried as assets.

In point of fact, referring to machine patterns only, a large stock of wooden patterns is a source of constant expense, requiring great storage room—which must be neither damp, too cold, nor too warm—large insurance, and the care of one or more attendants, and individual patterns are often not used for years together, while at a forced sale these costly patterns would bring absolutely nothing. Yet it is a very common thing to find patterns appearing in factory accounts as assets of many thousands of dollars in value.

The prime object of factory accounting is surely to present to the eye of the manager a correct and faithful showing of the actual values under his control. Are those actual values the probable forced-sale realizations, or are they the radiantly-hopeful supposititious values dependent on good trade and an abundance of orders?

To the purely commercial mind, taking nothing on chances, the forced-sale value must appear to be the only proper value to be given to factory plant in the accounts. To the mechanical mind it seems preposterous to write all the cost of these highly-valued shop treasures directly into the expense account.

The one method makes the books show what could probably be realized if the factory doors were closed. The other method makes the books show the factory to be wealthy in many cases where it is really bankrupt. It makes no actual difference in the cash in bank whether these disputed items are written into expense or assets. Account footings are not cash. But erroneous assumptions as to values, leading to erroneous asset totals, are very likely to lead to errors in management, and surely the last thing in the world to be desired by a factory manager is a self deception, leading him to believe his cash resources larger, and even vastly larger, than they really are.

It is perfectly true that the first requisite of commercially-valuable factory accounting is itemization showing correctly in minute detail where the money goes. In the old days of the machine shop it was a common thing to keep a "shop" account, and charge this shop account with all expenditures not directly entering into the salable product. Both labor and material of every description went into this shop account, lumped together, and the footing told the manager the mere total of indirect expenditures, and gave no indication of possibly economical changes in factory methods because the various items of expenditure were not classified.

The modern factory accountant divides the items of indirect expense into building maintainance, plant betterments, machine repairs —which open a repair account with each department of the factory, with each detail of each department repair, and often with each individual machine—certainly with each separate class of machines in the factory plant—and so on; he knows, or believes he knows, exactly what the factory pays for sweeping floors, carting ashes, and oiling shafting, and aims at minute exactitude in all records of indirect expenditure. This inevitably leads to a close scrutiny of every item of this class, thus enabling the manager to decide readily on changes of methods or men; it also leads directly to the view that all such items

of indirect expenditure as are devoted to permanent betterments of buildings, tools, or plant generally, go towards the reduction of the cost of merchantable product, and hence should be credited as assets, either wholly or in part, although, as previously pointed out, there is no possible way in which these items can be made directly to return the cash which they cost. They are of value to the going concern only, and do not bring anything at forced sales.

But the modern factory accountant must of necessity have a judicial mind and also an active conscience. He must be able to perceive clearly the whole result of his indirect expenditures, and he must apportion his charges correctly according to these effects. These needful qualifications of the good factory accountant lead, in many cases, to really exasperating shadings and divisions of indirect expense, often involving much clerical labor, and particularly obnoxious and aggravating to subordinates who lack the wide view and high sense of justice and quick conscience of the superior accountant who installs the system.

The subordinate says: "Why is all this unending labor of useless hair-splitting added to the really useful part of my work? Why must I be always on the outlook for the prescribed final disposition of these small and trifling items, which might just as well go bodily into the general expense and be done with it, as be split up on some fanciful scheme of percentages and charged into some of these minor divided accounts, none of which can ever be returned in direct cash?"

From the standpoint of the subordinate his complaint is well founded. The chief accountant, is, however, likely to resent such criticism with an intensity of acrimony precisely proportioned to his real breadth of view, sense of justice, and activity of conscience. Hence the chief accountant says: "The object of our whole accounting system is to group allied items of expenditure finally under headings which correctly represent the ultimate results of such expenditures. True, the money has gone, and will never be returned in direct form. Part of this money has been so expended that it has no future earning powers; part of it has been so placed that it has large and valuable future earning powers. I might as well throw away the whole system as fail to recognize these differences in results."

Consequently the chief accountant commands the subordinate to follow the system, and the subordinate obeys under strong mental protest, and a condition of high frictional resistance is established and maintained permanently, much to the detriment of the comfort and efficiency of all concerned.

This is no merely fanciful supposition. In one of the largest and best of American machine-tool factories a cost-system was, and probably still is, in use which involved a large number of minor divided expense accounts. This system was installed by one of the chief owners, a man of naturally high abilities, with great breadth of view and keen sense of justice, who has given a vast amount of consideration to factory accounting, has traveled extensively both in Europe and the United States, and is familiar with both the general theory of factory accounting and the particular systems adopted in many establishments of high repute. Yet the cost-keeper of this large establishment, who with seven assistants found it difficult to gather and separate the items of expenditure according to the system installed, had no hesitation in saying with bitter emphasis that all this unremitting labor of cost-keeping brought in absolutely no valuable return, and that in his opinion, in view of the constant friction caused by the exercise of autocratic authority necessary to carrying out the details of the cost gathering, the factory would actually be better in every way if the whole cost-keeping system was thrown out of the door.

In this case at least, it was clearly evident that, however valuable detailed information as to minor expenditure items may be to the manager, there is yet a limit to the subdivision of accounting beyond which it is highly undesirable to go.

Probably there will always be very wide margins of difference between the methods of really successful factory accountants, in this particular of the final disposition to be made of indirect expense items. There is always the choice to be made between the view that regards closed doors and forced sales as a possible finality, and the view that holds the factory to be a vital individual existence, with probabilities of immortality. In point of fact, factories begin, run their course of natural life, and die, like all other creatures; so much is certain from the daily record of current events.

Some factory accountants will hold to the theory that their business is to deal with going concerns, and that the factory with closed doors, dead and gone forever, is not a profitable subject of consideration. These accountants will carry a greater or less proportion of the indirect expense into accounts showing as assets. Other factory accountants, taking heed to the fate of all human enterprises, will have closed doors always in their mental view, and will write directly into the expense account all outlays which cannot reasonably be expected to return in cash or bankable paper, with no saving clause whatever as to future earning possibilities.

THE REGULATION OF THE YELLOW RIVER IN CHINA.

By William Starling.

Native Chinese River Boats.

WITH the exception of one tract, China is a mountainous country, though with countless fine river-valleys and plains. The general profile of the region is an immense slope, from the great table-land of Thibet to the sea, interrupted, in the northern part, by the Great Plain.

There are at least three well defined mountain systems in eastern Asia; the Tien-shan, the Kwen-lun and the Sinian. The first is not found south of the Gobi basin, though it projects its spurs far into it; the second runs in a nearly east-and-west direction; and the third stretches from south-west to north-east, beyond the limits of the Chinese Empire.

North of the Great Wall and stretching far to the west, even to the base of the Pamir uplands, lies a vast undrained tract similar in most of its features to the Great Basin of the United States. It is bounded on all sides by mountains. The rivers which rise within it have no exit from it. The basin is what an American would call an alkali plain. It is flat, sandy, and with a very scanty growth, due to an arid climate. It is called by the Chinese the "Dry Sea." It is usually denominated the great Desert of Gobi.

By some circumstances of which we are not apprised, gaps were opened in the margin of the basin and some streams found drainage for themselves. The dimensions of the basin were correspondingly reduced. Consequently, surrounding the Gobi basin proper there is what has been called a transition region, which partakes of the desert character and had evidently a common origin with the basin, yet does not drain into it.

In the engineering activity which is certain to follow the restoration of order in China, river improvement will play no inconsiderable part. Transport requirements alone would bring about this result, for nowhere in the world, perhaps, are waterways more depended upon, even to the exclusion of the roads. But beyond that, the great rivers which have been the cause of so much disaster in the past must be brought under control. The largest of these problems is taken by Mr. Starling as his theme.—THE EDITORS.

South of the desert, in one of the many ranges of the Kwen-lun, in the northeastern part of Thibet, the Yellow River rises, in a wide valley, dotted over with eight or nine lakes, great and small, and called, from this circumstance, the Sea of Stars. From this region the river makes its way, receiving many accessions from mountain streams, through and around the parallel ridges of the Kwen-lun system.

After escaping from the mountains, at a distance from the source of about 700 miles, the Yellow River pursues a career varied and tortuous to an extent which has few counterparts among rivers. First through the foot-hills and the steppe-land forming the periphery of the Gobi basin to a distance of perhaps 500 miles; thence turning nearly at right angles to the east through the country of the Ordos for some 130 miles more; then another right angle, and through the high plateaus of Shen-si and Shan-si to the south, where, so to speak, it is brought up with a round turn by the granites and crystallines of the eastern extension of the Kwen-lun Mountains, whence it started 1,700 miles higher, and forced into a course which is more acute than a right angle to its former direction.

HOUSE BOATS AT SU CHAU.

The Ordos country belongs to the transition region of which mention has been made. It is a part of the desert in all but the drainage. The basin of the river here is very narrow. Through the mountain country it had been well watered, but here it receives no tributaries and probably loses a portion of its volume.

As the river progresses eastward toward the highlands which bound the desert country, the condition improves. The rainfall is greater and the river receives a larger proportion of it. At the second right angle mentioned above, where the river turns south, it is fairly within the mountain region, and has entered upon that part of its

CHINESE WATERWAYS. SU CHAU CREEK.

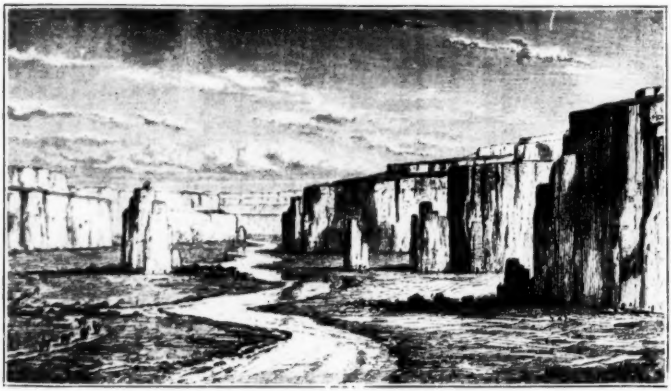
course which is to decide its destiny. It is in China proper, and forms the boundary between the important provinces of Shan-si and Shen-si.

These are mountain districts, formed by ranges of the Sinian system. They are cut in two by the Kwen-lun axis in the south of Shen-si and in Ho-nan, where the ranges of the latter system form the right bank of the Yellow River.

The mountains of Shan-si form an elevated ridge dividing the valley of the Yellow River from the great plain. At the eastern base of the mountains lies Pekin. Everything to the east of the watershed flows into the Pei-ho system.

The mountainous region of Shan-si and Shen-si, through which the Yellow River now runs, is a plateau composed of nearly horizontal carboniferous strata, superposed upon older rocks and overlain on their flanks by heavy deposits of loess.

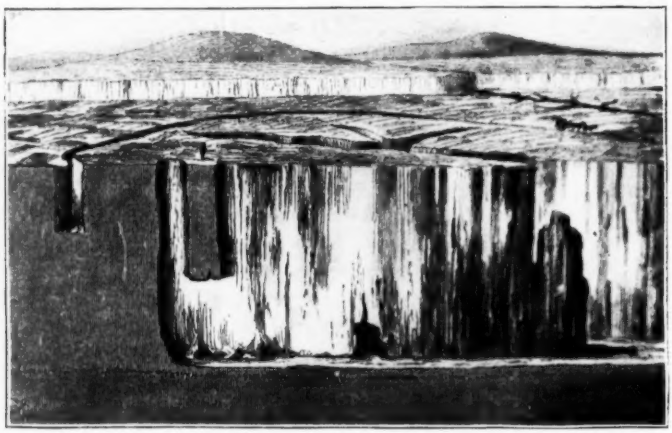
Loess is a material which is very widely distributed over the earth, and which by its peculiarities excites attention and is easily recognized wherever it is found. It was first observed on the Rhine; then, prob-



A LOESS LANDSCAPE. FROM RICHTHOFEN.

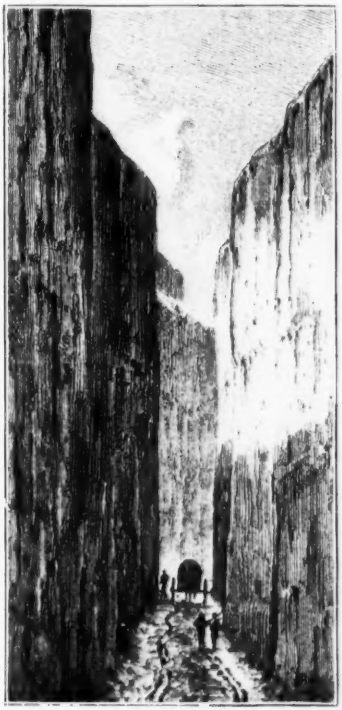
ably, in America; and finally it was noticed, in 1862, by Mr. Pumpelly, in China. It has, in that country, been made the subject of special study by the eminent traveler and geologist, Baron von Richthofen, and a theory of its origin has been evolved by him which has been much discussed, and finally, so far as the Chinese formation is concerned, has been generally accepted.

Loess, wherever found, is a yellowish, brownish, or grayish earth which is so soft and friable that it is easily reduced to powder between the fingers, and yet of so firm a consistency that when undermined by currents of water or other disturbing influences it will stand in per-



SIDE WALL IN A LOESS RAVINE, WITH SMALL CAÑONS. FROM RICHTHOFEN.

pendicular walls several hundred feet high. The cuts given herewith (taken from Richthofen's China) give interesting examples of this peculiarity. The particles composing the earth have been, by some process, reduced to such a minute state of division that it is asserted that they can be rubbed into the pores of the skin and disappear, without leaving any considerable residue. It is clayey in appearance, owing to the extreme fineness of its particles, yet when closely examined it is found to consist mostly of sand, which has very little appearance of having been subjected to attrition, but is sharp and angular. There is a considerable proportion of lime in it, which furnishes the cement necessary to hold it together. It is very susceptible to the attack of currents; and while it is said that it soon subsides from still water, it is carried long distances by streams.



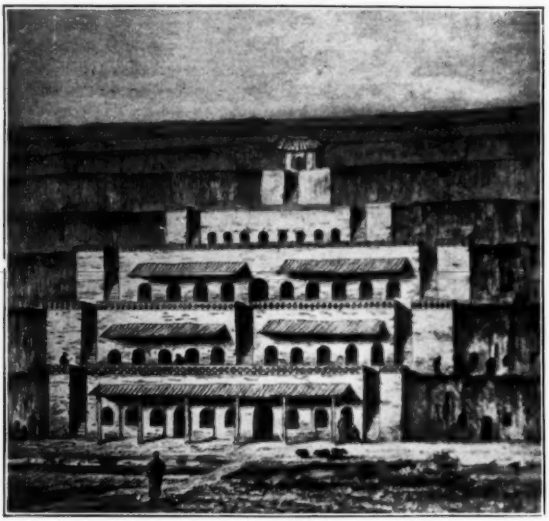
SUNKEN ROAD IN THE LOESS.
FROM RICHTHOFEN.

Loess is very common in the Mississippi valley, being found from Pierre in South Dakota to Baton Rouge on the Mississippi. It forms the bluffs of Council Bluffs, Quincy, and other localities on the upper river, and of Memphis, Vicksburg, and sundry other points on the lower. In America and in Europe its utmost thickness is 100 or 200 feet, but in China it has a development of ten times that much.

The Sinian mountain system of China has been compared to the Appalachian system of America.* Certainly the Carboniferous plateau of Shan-si and Shen-si bears a strong resemblance to the Cumberland plateau, and still more likeness to the Ozark plateau of Missouri and Arkansas. The loess, in China, does not cap the highest eminences, but rests against the flanks of the older strata. The highest parts of the plateau of Shan-si stand about 7,500 feet

* Pumpelly, Geological Researches in China, etc., Washington, 1867, p. 68.

above the sea, though generally the elevation does not exceed 5,000.* The loess is found at all heights from 400 feet to more than 7,000 feet. The thickness is thought to reach 2,000 feet in places. It is very commonly as much as 1,000. It does not by any means cover the whole mountain region of the two provinces named. On the immediate



A LOESS VILLAGE. FROM RICHTHOFEN.

banks of the Hwang-ho it is conspicuously absent. Its greatest development is along the tributaries, especially the Fonn-ho.

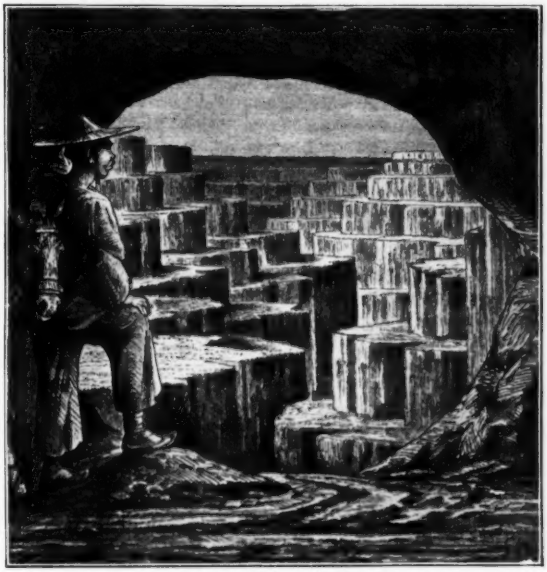
Where the loess formation is predominant it impresses very remarkable features upon the landscape and even upon the life of the population. Its characteristic property of standing vertically is everywhere displayed. Roads are soon worn into the earth, the walls on either side still retaining their perpendicular, till in the course of years there is formed a sunken road perhaps 70 or 80 feet beneath the level of the plateau. Often there are successive cuts which are transformed into terraces, and houses or villages built upon them after the manner of cliff dwellings. Indeed, chambers are frequently excavated deep into the walls, and even whole suites of rooms. In fact, as Richthofen says, the dwellings vary from simple caves to veritable loess palaces.

Similar things occur in the loess districts of the United States. Near Natchez, in Mississippi, and no doubt at plenty of other places,

* Richthofen, China, Vol. I., p. 73, and sections on p. 58.

where the loess formation prevails, sunken roads may be seen, 20 feet or more in depth, with vertical sides. During the siege of Vicksburg the people dug themselves bomb-proof shelters in the loess. In Nebraska and Kansas "dug-outs" in the same kind of soil are not, or were not, uncommon.

The passage of the Yellow River through the Sinian plateau is a veritable cañon, some two miles wide and 1,500 feet deep, deeply incised in the Subcarboniferous limestones, and without even a strip of bottom land. Here the river receives large additions to its volume, both of water and of sediment, through numerous and powerful tributaries, which enter from both sides, but especially from the west. The headwaters of these streams are divided only by a narrow watershed from the tributaries of the Yellow River in its first upper course to the north, in the Kwen-lun Mountains.

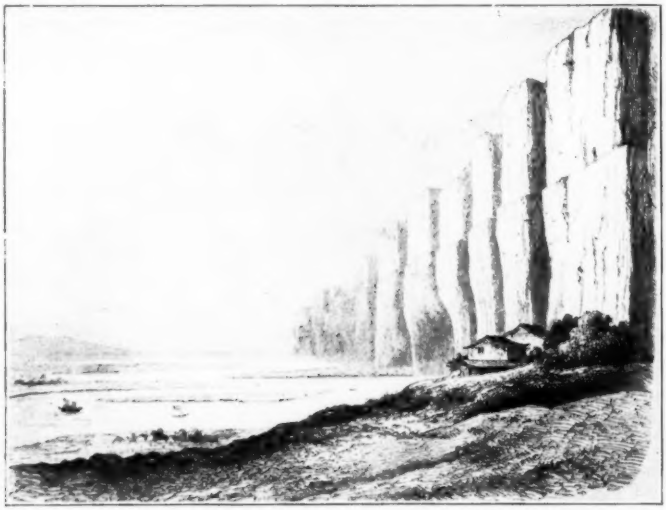


LOESS LANDSCAPE. FROM RICHTHOFEN.

The principal tributaries in Shen-si and Shan-si are the Fonn-ho, the Lo-ho and the Wei-ho. These are rapid mountain streams, with numerous smaller affluents, all running through loess districts. Neither they nor the Yellow River itself are navigable in this part of their course. Below the mouth of the Fonn-ho the hard rocks which

have hitherto formed the banks of the main stream give way to loess, and henceforth this or the alluvium is the surface formation, except where the river has cut through the superficial mantle and has made its bed in the harder underlying Paleozoic or Archean rocks.

The great bend alluded to is caused by the massive granite range of the Kwen-lun stretching across the path of the Hwang-ho and deflecting the latter sharply to the east, to send it, in 145 miles more, into the great plain. At the foot of the bend the fortress of Tung-kwan uprears itself on the top of a high loess terrace, and a little to the west is the high granite hill of Ta-hwa-shan with its temple.* Here the



LOESS WALL ON THE YELLOW RIVER, NEAR THE BEGINNING OF THE DIKE SYSTEM. FROM RICHTHOFEN.

river receives the largest of its affluents, the Wei-ho. In spite of the rocky walls which line the sides of its greater valley, the actual banks of the river consist of loess precipices; on the left 200 feet high, on the right 800 feet. Till the river makes its exit from the mountains, high loess walls rise from the water's edge, sometimes on the one bank, sometimes on the other, while on the opposite side there is often a strip of alluvial bottom. Here and there the stream is closely hemmed in on both sides, as at Tung-kwan. The current is always swift. Often the stream is divided by sand bars into two or more channels. Sometimes the bed is composed of rock or gravel. The Yellow River, in this

* Richthofen, China, Vol. II., pp. 546 and following.

ON THE UPPER YANGTSZE-KIANG.

stretch, or indeed in the whole mountain region, is not fit for navigation. In fact, it is not navigable except for the smallest kind of boats till it reaches the point where the new course branches off, since the break of 1852, some 20 miles east of Kai-fong-fu.

For 60 miles or so after leaving the mountains the right bank is bounded by high loess bluffs, of which a sketch is given, taken from Richthofen. On the left is a tract of sandy overflowed land reaching

RAFT ON THE UPPER YANGTSZE-KIANG.

to the foot of the mountains of Shan-si, 15 or 20 miles distant. Beyond this strip, and on the zone of rich detritus brought down by the washings of the mountains, lies the famous Hwai-king tract, the Garden of China.* The Great Plain is a roughly-trapezoidal area, lying between the mountains and the sea, extending from about the 30th to the 40th degree of latitude, or nearly 700 miles, in length, and in breadth from 100 to 500 miles. It is partly interrupted, on the sea side, by the mountainous peninsula of Shan-tung, and the southern end has a ragged and irregular outline, caused by the projection into the plain of several spurs of the highlands south of the Yang-tse-kiang. Into this plain, near its middle, about the 35th parallel, the Yellow River debouches. There are two possible routes by which it may reach the ocean, north of the promontory of Shan-tung or south of it. It has occupied both of these in not very remote times. Up to A. D. 1194 it flowed north of Shan-tung, occupying, in a general way, what is now the bed of the Wei-ho (not the mountain tributary of the Yellow River of that name, but a tributary of the Pei-ho). In 1194

SHIPPING ON THE SHANGHAI RIVER

the river deserted this bed and elected to take the southerly course, emptying into the Yellow Sea about the 34th parallel. It followed this direction till about 1852, when it turned agan to the north-east.

* Richthofen, China, Vol. II., p. 521.

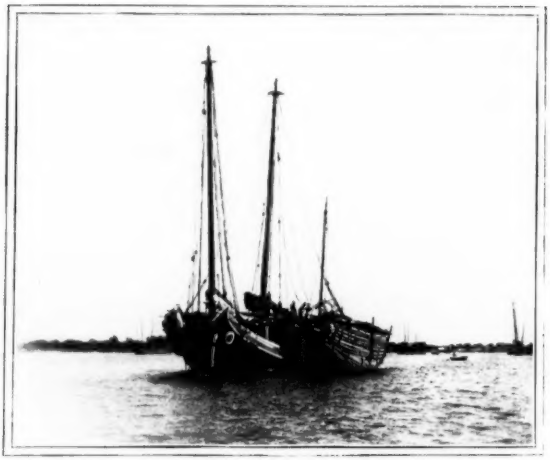
This revolutionary movement on the part of the river was not known outside of China for nearly twenty years, and the cause of it is merely matter of inference.

NING PO STEAMER

For the upper course of the Yellow River, from its source to the point where it enters the Great Plain, pretty much all the information we have is derived from Richthofen. From his text, cross-sections, and maps we are enabled to get a fair idea of the mountain part of the Hwang-ho. For the Lower River, as it will be called for convenience, we have more numerous sources of intelligence. Several intelligent travelers have visited different sections of the river, among them four experienced engineers, and some instrumental determinations of value have been made. The latest additions to our knowledge have been made by two Dutch explorers, Captain Van Schermbeek, of the Royal Dutch Engineers, and Mr. Visser, a member of a well-known contracting firm, who were sent out by the Society for the Promotion of Dutch Engineering Works Abroad, in 1889, for the express purpose of securing accurate information about the Yellow River and ascertaining its capacity for improvement. Their report was printed in 1891,* with a prefatory memoir by the distinguished engineer, Mr. Fijnje, and the whole volume contains a vast deal of

* Memorandum relative to the Improvement of the Hwang-ho or Yellow River in North China, by J. G. W. Fijnje van Salverda, and Report of Captain P. G. Van Schermbeek, Royal Dutch Engineers, and A. Visser, on their Inspection of the Yellow River and Its Flooded Districts in 1889. The Hague, 1891. Privately printed.

Of this valuable publication unfortunately only 200 copies were printed. The writer is indebted for his copy to the kindness of Mr. Fijnje.



BAMBOO POLE BOAT ON A CHINESE RIVER.

valuable information on the subject of the Yellow River and of river improvement generally. To these gentlemen, to Mr. Morrison, and to General Wilson we owe pretty much all the precise information we have about this interesting and perplexing stream.

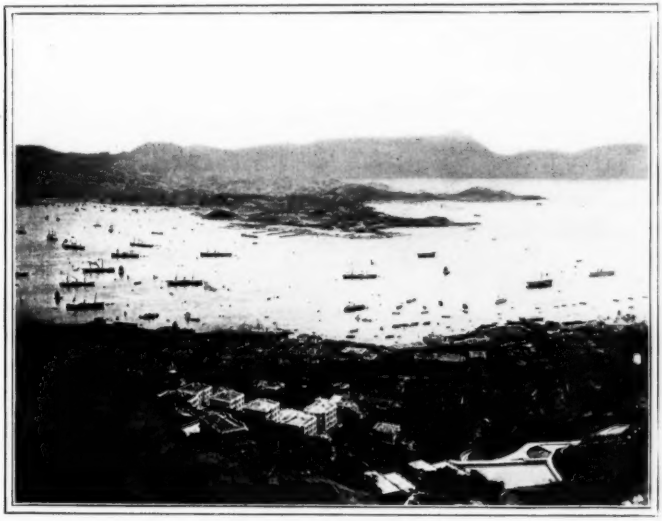
The Hwang-ho is not one of the great rivers of the world, as is sufficiently shown by its name. We are told that the word *ho* is not applied to rivers of the first class, the name *kiang* being reserved for them. Its drainage basin is said to have an area of about 475,000 square miles,* of which a considerable part lies in the desert. Its length is estimated by Mr. Fijnje as about 3,760 kilometres (say 2,330 miles), or probably more. General Wilson compares it, where it was seen by him, in respect of color, volume of water, and even the character and appearance of its foreshores, to the Missouri above Bismarck. It was less than 1,400 feet wide, in the average, with low banks and a shallow channel. Where it was seen by Captain Van Schermbeek and Mr. Visser it was of very irregular width and depth, the sectional area being something like 9,000 square feet at a rather low stage. The plains are almost perfectly level, and stretch away for hundreds of miles without the slightest rise or depression.†

The Yellow River bears a general resemblance to the Missouri in some respects, while in others it is more like the Arkansas. It is

* Wilson, China, p. 36.

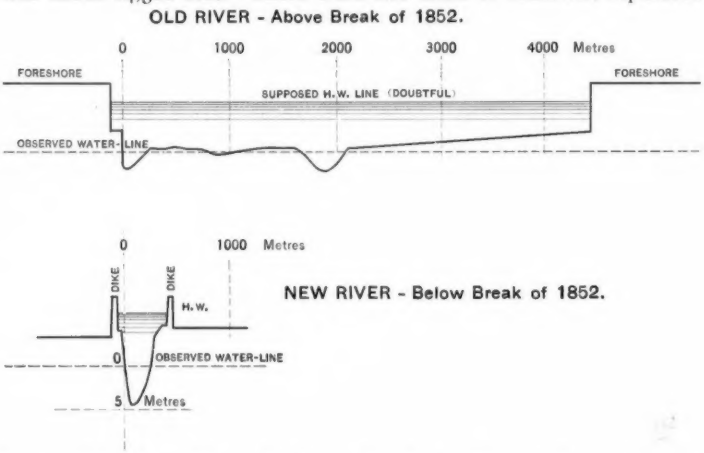
† Wilson, China, p. 35.

distinguished, however, from the American rivers, if not, indeed, from all known streams, by the character of the deposits through which it flows previously to entering its alluvial plain, and the tremendous change undergone by its slope and velocity in making the transition from a mountain to a lowland career. There is nothing ever yet observed, or at least reported, that compares with the thickness and abundance of the loess deposits of Shan-si, Shen-si, and Ho-nan. The nearest approach to it is found in the Bad Lands of the Dakotas. In the latter instance, however, the material is less erodable, its thickness and extent are less, and the slopes of the streams are far inferior. The elevations given by Richthofen were determined by the barometer, and it is not always easy to tell how far above the water the point of observation was situated; but from such data as he gives it would appear that the difference in elevation of the Yellow River, from the great bend or right angle at Tung-kwan to the point of debouchement into the plain, about 145 miles, is about 580 feet, or at the rate of 4 feet to the mile. After entering the plain the slope is somewhat better ascertained. Several instrumental measurements showed the slope of the river in the upper part of its course in the plain to be about one foot to the mile. Nearer the sea, it would seem, from barometrical observations, to be somewhat less, as might be expected.



THE HARBOR AT HONG-KONG.

The width of the Yellow River was taken by General Wilson at several points, from Kai-fong-fu down, and found to be 1,500, 983, 1,656, and 1,092 feet, an average of rather more than 1,300 feet. The cross-section was measured by the Dutch engineers at two places, one above the break of 1852, the other below that point. The upper section was very wide, and five-sixths of it were taken up by two immense sand-bars, bare at low water but covered at high stages. On either side of the river was a high foreshore, two miles broad and above high-water mark. It must be remembered that the break of 1852, 20 miles below, had made a radical alteration in the water-level of this part of the stream. The breadth of the river between the foreshores was about 14,300 feet. There were two arms or channels, separated



by a width of sand-bar of about 4,600 feet. The northern arm was 1,340 feet wide, with a mean depth of 3.2 feet and a mean velocity of 2.7 feet; the southern arm was 890 feet wide, with a mean depth of 4.1 feet and a mean velocity of 4.7 feet per second. The total cross-section was about 9,500 square feet, and the total discharge about 31,000 cubic feet per second. The lower section, taken in the new course of the river, about half-way toward the mouth, was fairly regular in shape. It was about 1,080 feet wide and about 10 feet deep. The dikes on the opposite sides of the river were only about 1,700 feet apart. The sectional area was 10,800 square feet, the mean velocity 4.25 feet per second, the discharge 45,500 cubic feet per second. The river had risen in the meantime. The high-water section, as well as it could be determined, was about 44,000 square feet. What the high-

water discharge would be is not so easy to say. Data are scant and formulas tricky. The slope of the Yellow River, in this part of its course, seems to be about the same as that of the Missouri. At Kansas City, in the great flood of 1883, the width of the river was 2,184 feet,

THE WHONG POO RIVER.

the mean depth 27.3, the cross-section 59,500 square feet, the mean velocity 6.2, the discharge 370,000 cubic feet per second. The depth is about the same, the other dimensions greater in the American river. The discharge of the Yellow River probably did not exceed the figure given.

The dikes or levees which border the river do not begin immediately upon its entry into the plain. About 65 miles below the foot of the upland slope the Tsin-ho empties into the Yellow River from the north. The left bank of this stream is the continuation of the detritus slope from the base of the mountains, and is above overflow. Here begin the dikes of the left or northern bank, in about longitude 113° 36′. A few miles below this point (in longitude 113° 40′) the high loess walls on the right bank leave the river, and here the dikes of the right bank begin, resting upon the loess wall.*

The great break of 1852, by which a new direction was given to the river, occurred at a point about 20 miles east of Kai-fong-fu, or 70 miles below the head of the levee system, or 135 miles from the foot of the mountains. Above this point the levees are essentially the same that they have always been. Below it, they are of new construc-

* Memorandum relative to the Improvement of the Hwang-ho, p. 71.

tion. The length of the new line is about 310 miles. The break of 1887 took place about 20 miles above Kai-fong-fu, in the old dike. It was closed on the original line.

Frequently there is a double line of embankment, as is often the case in Europe; one, the main line, being placed at a considerable distance from the river, for security against the erosion of the banks; the other (what the Dutch would call the summer levee) being designed for the protection of the foreshore, which is often extensive and valuable, and sometimes includes cities.

The dimensions of the dikes vary widely. So far as height above flood-level is concerned, the elevation of the water-surface above the break of 1852 has undergone such an alteration by that event that it is difficult to tell what it was. The water level has been much depressed, and the levees now stand very high. Even the foreshores are sometimes above overflow, as we have seen. In the neighborhood of Kai-fong-fu, about 20 miles above the break of 1852, the existing levee is the remnant of a gigantic embankment built by the emperor Kien-lung, more than 100 years ago. This massive work is described as being 40 feet high and 50 feet wide on top, with slopes of 1 on 2. Doubtless, as General Wilson says, it was intended to show how levees ought to be built. It extends only a few miles up the valley, but for a considerable distance along the old abandoned course south of the Shan-tung hills. Below Kai-fong-fu, along the new course of the river, the embankment was found to be from 12 to 14 feet high, with a crown from 20 to 30 feet wide and slopes of 1 on 2. "In many places and for considerable stretches it was well laid out, admirably constructed and in excellent condition, but at others it was not only crooked, but of insufficient height and width, and was in bad condition generally. It was frequently cultivated on the top and sides, cut

SUCHAU CREEK AND BRIDGE.

through by road crossings, and burrowed into by animals. The same may be said of the embankments wherever we come to them."* The dikes, where they were measured by the Dutch engineers, were about 12 feet high and something more than 3 feet above high water. The crown was about 23 feet, the slopes from 1 on 2.5 to 1 on 3. The foreshores were usually high.

The observations of General Wilson in regard to the neglect of the ordinary precautions for the safety of the dikes are yet more emphatically stated by the engineers of the Dutch syndicate. None of the levees is sodded. They saw people engaged in plucking out the last stalks of grass on the slopes for feed for their cattle. The embankments are worn on the outer slopes by erosion and on the inner slopes and crown by wagons, etc.

In short, the levee system of the Yellow River, like many others, is a piece of patchwork, built from time to time, by many administrations, at widely different dates, with great diversities of means and of wisdom. Sometimes the dikes are superfluously high and strong, sometimes they are altogether insufficient. They are always neglected. The river is suffered to get dangerously close to them, by bank erosion, the slopes are not protected by a sward of grass against rains and currents, and they are cut up by travel.

A great deal of care has been taken by all professional observers to ascertain the causes of the different breaks for which the Yellow River has such an unhappy notoriety, and to inquire into the truth or falsity of the often-repeated assertion that the bed of the river has been raised by its own deposits in consequence of the construction of the dikes. There is no evidence in any instance that the breaks were caused by the water of the river running over the tops of the dikes. "The breaches of 1852, 1868, and 1887," say the Dutch engineers, "along the old elevated course of the Hwang-ho, were not caused by overflow of the dikes, but because nothing was done to put a stop to the incessant changes of the channel of the river, till at length it reached the dike and undermined it till it succumbed."† So thinks General Wilson. It is not necessary that the river should actually cut away the levee to cause a break. If it cut into the base of the embankment it may so undermine the foundation of it (which is its weakest part) that the pressure of the external water will literally knock the bottom from under it. This is especially likely to happen in weak soils, and loess is the weakest and most treacherous of all. If we take this into

* Wilson, China, pp. 245-6.

† Memorandum relative to the Improvement of the Hwang-ho, p. 98.

account, the want of sodding and the neglect of proper precautions, we need not look very far for the causes of breaks.

Mr. Morrison found that the bottom of the river near the break of 1887 (which was in the old part of the river, above Kai-fong-fu) was from 3 to 4.5 feet above the natural surface of the adjacent lands. Messrs. Van Schermbeek and Visser agree with him. It is possible then that for the first hundred miles or so after leaving the mountains the river is compelled to lay down a portion of its burden, levees or no levees. When we consider that the river has just been flowing through a mountain country, heavily covered with loess, and with an abundant rainfall in time of high water, at a slope of 4 feet to the mile, and forced to traverse a comparatively flat plain, with a slope of 1 foot to the mile, it is not surprising that it can no longer support the burden of yellow mud to the amount of 1/180 to 1/270 of its weight, which it has been carrying. That this condition has been aggravated by the construction of levees is in the highest degree improbable, if not impossible. The building of levees would give greater velocity and transporting power, and would tend to mitigate the evil, though it might not entirely remove it. The trouble seems to be confined to a small part of the river, from the beginning of the levees to the neighborhood of the break of 1852, a distance of, say, 75 miles. Below this point, in the new course which it has been pursuing since 1852, it is evident that the river is engaged in exactly the opposite process from filling up its bed; for it is scouring it out. For many years after it broke through the dikes on the left hand it flowed undisturbed. It was not till 1878 that the new embankments were completed. Between these dikes the river was left to make its own bed. This it has done. General Wilson says, in 1886:

"I found that it had gradually made for itself a new channel, with shores from 5 to 10 feet in height, and that it was otherwise assuming the characteristics throughout that portion of its course which it has above and below."

The remedy proposed by the Dutch engineers is a thorough regularization of the river, at least of the critical part of it, after the manner which they have found successful at home. He would be a sanguine, not to say rash, physician who should prescribe a course of treatment for such a refractory patient without having seen him and carefully studied his case. We may say, however, that the difficulties have been greatly exaggerated, and may agree with those who have seen the river, that its improvement does not present any insuperable obstacles.

THE MEANING OF COMMERCIAL ORGANISATION.

By A. Hamilton Church.

THE development of industrial and particularly of manufacturing operations has been so rapid in the latter half of this century that it is not surprising to find some portions in a state of relative backwardness. This is particularly the case, as indeed might be expected, in those departments in which the actual productive factor does not come into active play, but which are rather concerned with methods of working and with the effecting of adaptations from the old order of things to the new. We have progressed indeed, almost without realising it, from an era in which all mechanical operations were of the simplest character, demanding no very high order of intelligence but merely a certain manipulative skill and craftsmanship, to the present time in which the actual mechanical problems are almost subordinated to questions of co-ordination and of simultaneous production under conditions of imperative exactness and accuracy.

The spectacle afforded by a modern works of the first grade is one of a great series of independent operations, carried on out of sight and for the most part out of knowledge of one another, but so carefully and cunningly devised that their products are in perfect co-ordination. When we contrast this with the machine works of a hundred years ago, in which a "mechanic" was one who exercised all branches of a craft, to-day split up into almost numberless separate pursuits or callings, the truth is realised that this ancient condition of things not only no longer exists but has no possible parallel in our day.

To the toilsome and uncertain progress of the "base mechanic" of our polite forefathers came the enlightening spark of genius from the brains of a host of great mechanicians, transferring the area of possible triumphs from the merely manipulative to the mental field. It became no longer a question of a single device painfully wrought into shape by almost unassisted hand labour, but of the coming of machines which were of themselves producers, and far more accurate producers than the most skilful craftsman ever was.

The advent of the machine tool, with its endless reproductive powers, with its yet unexhausted possibilities in the way of division of

Mr. Church, the associate of Mr. J. Slater Lewis, is one of the leaders of the new science of modern manufacturing. The strong feature of his article is his demonstration that organisation is an integral and even basal part of successful works management—not merely an auxiliary to it.—THE EDITORS.

labour, and its infinitely greater accuracy and power, was bound to revolutionise and transform the operations on which it could be directed. But this of itself is perhaps the least important of the changes differentiating the old from the new order. Close on the heels of the machine tool came the necessity for an altogether higher type of intelligence to control the increasing complexity of industrial operations. The "mechanic" disappears; in his place we have the "captain of industry," with his keen intelligence fully awake to the interaction of complex forces whose field is the whole world; he requires the capacity not merely to manipulate iron and steel, but—a much rarer gift—to understand men of many capacities and of a number of different social grades. To-day, indeed, the manufacturer might be said without much exaggeration to be the pivot on which society at large revolves. On his training, his intelligence, and his fitness for his life-work depend the future and destiny of nations. So true is this that it is almost a truism, recognised publicly by the frantic rush for technical education or whatever other panacea is fashionable at the moment for spreading the glamour of hope over the cruel statistics of diminishing or non-progressive trade.

The most progressive manufacturer is bound and limited, however, by the environment in which he finds himself. If it is true that industry is undergoing a process of change which is as yet far from finality, it is still more true that the process has many currents, and that it is impossible to master and turn all of them to account by a sudden effort, or by partial measures of reform. The older and the larger the undertaking, the more cautious we must be in making changes and the more resolute not to be satisfied with a fractional success. In an old organism the roots are deep, and their ramifications are not at all on the surface. Even in the interior arrangements of great factories there are vested interests that the most despotic reformer will hesitate to disturb, preferring to undermine than to carry by assault. What a writer in THE ENGINEERING MAGAZINE has well termed the "departmental ogre" has to be reckoned with, and it is a matter of intelligence rather than strength to do so.

All these considerations tend, as it happens, to one and the same result. Reform begins and generally ends with the modernising of machinery and non-productive appliances in that department, such as cranes, shop-transport, tool-rooms, and the like, leaving untouched the system of nerves, by which the whole is directed, and the importance of which has been recently brought into the light of day by the appearance of Mr. Slater Lewis's great work, under the title of Commercial

Organisation. The general effect of leaving this important section out of account is much the same as that of trying to restore life to a dying man by mounting him on a bicycle, instead of by building up the decaying tissues first.

Small wonder it is that drastic re-organisations often fail to give relief. Co-ordination is the keynote of modern industry, but it is a word of which the meaning is too often ignored by would-be reformers. Add that co-ordination is the very antithesis, the irreconcilable opposite, of rule of thumb, and we see the reason why the introduction of modern appliances does not always spell commercial salvation, but may even hasten the day of disaster. Congestion of work, dislocating the even flow of output, is no rare phenomenon; but it is getting to be a more and more inexcusable one, in so far as it does not arise from a sudden and unforeseen press of business.

Nothing is less elastic than the commercial organisation of a large place of business. Nothing clings more closely to tradition. The lines by which communication between the various departments is effected tend to wear ruts, out of which it is not permissible to jump. There is no remedy for this. The system will never be devised that will change with new conditions of the work it has to perform. The case of our government departments is a notorious example of systems once and temporarily good which have been left to harden and petrify. Most old businesses show on examination a similar state of results. As it is in the nature of things that this should be so, we can only look to the remedy, and no deeper. The remedy is to be continually on guard, and to bring the whole question under review when it is known that new factors have entered into actual practice. That this condition exists in most engineering concerns is evident enough.

From a practical point of view it may be said that as co-ordination is the imperative need of to-day, the nerve system must be re-arranged with that end kept steadily in view. The object of the commercial, or, as it might also be termed, the administrative organisation scheme, should be to collect knowledge of what is going forward, not merely qualitatively, but quantitatively; it should also provide the means of regulating as well as the means of recording. It is no mere matter of accountancy, although the element of cost is an important factor. Nor is the matter merely a technical one. It is essentially a matter of administrative control that is in question, stretching through every department and regulating the healthy life of the whole.

Having thus generally outlined the meaning of commercial or administrative organisation, a definition of its closer application to

practical affairs may be attempted. A common mistake is to assume that there exists any cut-and-dried scheme applicable without thought or trouble to various types of business. The fallacy has arisen in the confounding of book-keeping with organisation. Epigrammatically it may be said that there is some book-keeping in organisation, but that there is no organisation in book-keeping.

Local conditions will always demand the first consideration. With a good system as a basis, modifications may be arranged to suit these: but the operation is a dangerous one for amateur exercise. The reason is obvious. In a well-ordered system there are far-reaching tentacles, complex interlockings, disturbance of which may vitiate a good deal of the value of the new results. But the greatest danger is that a partial solution only is reached where a complete one lies within grasp. More especially must it be emphasised that a knowledge of what is termed prime cost is no evidence of an intelligent control of the commercial side of a manufacturing business. It is true that some small businesses manage to rub along without even this elementary attempt at systemising, but the majority of firms of any size have some sort of cost method, however rough and home-made, which enables them to tell how much labour and what value of material have been expended on any particular job. Between this elementary stage and the next there is a very wide gap, which is bridged over by comparatively few firms, even in the go-ahead United States. The analysis of the working indirect expenses of the business, and in particular the discrimination between "works expense"—that is, the expenditure on productive departments—and "general establishment expenditure"—representing the expenses of the selling organisation—is a principle the fundamental importance of which had only dimly been realised by the book-keeping mind, and was first given the prominence due to its importance in the Slater Lewis system.

There is yet another stage before finality is reached. When once the distinction has been pointed out, it is obviously not enough to know the mere prime cost of work, without taking into account the indirect expenditure of the particular shop or department in which such work is carried out. One job may cost exactly the same in labour and materials as another job, and yet be quite unremunerative if taken at the same price; for one may be made under totally different conditions, and in itself may be an entirely different class of product from the other; yet this difference is in no-wise reflected in the prime-cost accounts. The item "labour," for instance, may be representative of a large amount of cheap labour or a small amount of highly-skilled

labour, with a totally different incidence of indirect expense in either case. This is, to a large extent, set right by the above-mentioned analysis of works expenditure by departments, so that work done in one shop may be burdened more heavily with such indirect expenses than work done in another shop. But even when this is done, and when the local conditions peculiar to each department have been fully ascertained and means for the due reflection of this factor in the costs have been arranged, there still remains the problem of the department which, as a matter of practical convenience, cannot be divided up, but in which several diverse kinds of work are habitually done. To discriminate between these different classes of work when in the same shop is the third and final stage in the analysis of the statistical information called "costs," and it is the most difficult as it is the most important of all. It is not possible here to do more than refer to the existence of the problem; the discussion of the methods to be adopted for its solution requires separate and very detailed treatment.

The necessity for co-ordination already referred to is an inevitable result of the evolution of the factory. No one mind can grasp and hold all the details. The object of modern administrative organisation is to readjust the balance of responsibilities disturbed by the expansion of industrial operations, and to enable the central control to be restored in its essential features. If we seize this truth firmly we shall be able to criticise intelligently any proposals which may come under discussion, because this and this only is the proper perspective from which to regard all systems of organisation. Hence it will be readily seen that no method fulfills its purpose in which the operations are not immediately known, and their digestion and analysis subject to no delay. It is difficult, unfortunately, to realise the money value of absolute smartness in the presentation of results, until we remember that these results are our only substitute for that keen and active participation of the master's eye and brain in the daily progress of his work which is the life-blood of the small business, and which in the fortunes of industrial progress chiefly assists in its expansion into a large business. How many concerns languish when the care of their founder is withdrawn—and why? Simply because he cannot transfer the multitudinous details of organisation from his memory to that of a successor. It is these details that are essential, and it is their absence that must be fatal unless their place is supplied anew.

Nor must it be forgotten that the introduction of modern organisation is not in any sense the reduction of the subordinate to the *rôle* of an automatic machine. If it is true that mechanical devices—such

as the comptometer, the slide rule, and the card system—loom very large in the programme, this is because they are labour savers. Now it is not cheap labour that is the chief thing to be saved, but expensive labour. The clerkly drudge with his everlasting copying tends to disappear. But the necessity for intelligence does not tend to disappear. If anything, the trend is in the opposite direction. Fewer people, perhaps, or at least not more people, but people of a higher grade of intelligence. A well-known engineer said to the writer not long since "one of the chief things that hinders British manufacturing enterprise is that they do not get the right grade of people in positions of responsibility. They try to work the thing on a cheap scale. In America the highest types of intelligence find their life work in industrial operations, and—the result is getting pretty evident."

This indictment is no doubt true. The vast scale of Transatlantic enterprise renders it possible to use higher intelligence, which in Great Britain would be frittered away in so-called "learned professions," or, still more uselessly, in an amateur political career. And the converse is also true; the vast scale of enterprise is a result of the mental power engaged in industrial operations. In more precise language, the Americans are creating in the industrial arena an environment superior in intelligence and enterprise to that existing elsewhere in the world. Their consequent supremacy is inevitable unless other nations are prepared to tread the same path of reform.

In any system there will remain always a mass of work which is pure mechanical routine. Of this class is computation, and generally all those arithmetical processes which occur in the digestion of each day's operations. Amongst these may be cited: the extension of wages, of material, the computation of establishment charges, aggregation of costs, and all the additions of financial books, such as the sales journals, purchases journals, with their cross-classification totals, and the checking of all classes of returns involving the addition or multiplication of figures. All these operations are much better carried out by an accounting room fitted up with mechanical appliances for the work than by a number of men scattered about the offices and works, each painfully toiling to attain accuracy, and in most cases frequently failing to do so, thereby causing annoyance and confusion at a later date, probably at a most inconvenient moment.

To this extent it may be said that it is proposed to substitute mechanical methods for older ones requiring intelligence. Yet even here the substitution is more apparent than real. The operator of a calculating machine can find plenty of use for an even considerable

quantity of brains, whilst on the other hand the work of say, addition of long columns of figures, or the calculation of numbers of percentages, is drudgery pure and simple, and is usually paid at a low rate.

The most costly thing about a factory is an incomplete organisation. Yet the cost of establishing a good one is often shrunk from like the plague. The reason is particularly obvious where the principals are not their own managers, as in the case of almost all companies. The cost of establishing a new and better system is seen at once in the pay-roll; an additional clerk or a higher salary makes itself clear to the most obtuse board. "Expenses must be kept down," and so the proposal is vetoed. This may, nevertheless, be very far from clever business. The addition of £100 a year is seen, but what is not so clearly seen is the cost of mistakes due to an organisation outgrown. These are smothered. The shops can easily keep their own counsel. The ultimate result of such mistakes, failures of co-ordination, shows, of course, at the year-end in diminished profit in the "Trade a/c." But nobody knows why or wherefore. In the course of a year, several times the cost of a highly-paid staff may easily be muddled away in a large concern, and nobody be a penny the wiser. An incompetent foreman in one single shop, in the absence of proper control, may waste the firm's resources to a perilous extent, and yet the management may be only vaguely conscious that "So-and-So is not as sharp as he might be." The money value of his want of sharpness is an unknown quantity. It ought not to be.

With the growth of competition the necessity for co-ordination and of an accurate and swift presentation of results is more and more imperative. The margin for waste is less, the necessity for detail greater. Everything should be the subject of forecast as to financial results, and of prearrangements as to the actual carrying out. And when it is completed, the records of what did actually take place should be capable of comparison with what was intended to take place. Control then becomes a living reality. Co-ordination implies prevision, of necessity. The place where it pays to spend time and money on work is before it has begun the serious and irrecoverable expenses of production. It is the place, too, where it is most efficiently applied to produce a maximum of smooth working.

To sum up the principles on which a good system should be based and to enumerate the points that it should embrace is not as easy as it may appear, on account of the diversity of the local needs of each special business. With this reservation in view, it may be said that no system is satisfactory and complete in the fullest sense that does

not provide for the immediate serving up of its results, day by day, as they occur, that does not provide in advance for the progress of every piece of work, and that does not present its cost details interlocked with its general and shop establishment charges in such a way as to discriminate: (1), between incidence of indirect shop expenditure and incidence of office and sale-organisation expenditure; (2), between the incidence of shop expenditure in one shop and in another, and (3), between different classes of work in the same shop.

There should also be so close a control over the stores and shops that the present value of assets may be known at least once a month. This implies, as will be obvious to an accountant, that monthly balance-sheets must be furnished, with the advantages which a continuous audit gives. There will also be—what is no less important—a continuous stock-taking. The present state and cost of any order should also be known at any moment, without calculation or more than two references at the most.

With these arrangements should be coupled—in all businesses in which orders have an individuality, *e. g.*, machinery—a method of finding not only the total works cost, including charges, but also the expenses incurred by the individual order after sale, such as commissions, freight, customs duty, workman's out-time and travelling expenses, and the like. The difference between the aggregate of these sums and the sale price is the net profit on that transaction. The sum of all such profits in any period should agree with the profit as declared by the financial books. *Every item of profit, as well as every item of loss, should be traceable by the management, and no covering up allowed.* If these elements are established and intelligently made use of, we have as near approach to the restoration of personal control over the details of a large business as the situation permits.

The catalogue may seem formidable. No doubt a newly commencing business has the advantage in establishing a system of administrative organisation, as it has the advantage of being able to base its productive arrangements on the latest available experience. But if one were to hazard the crystallising of a suitable exhortation to the older type of manufacturer into one sententious phrase, it would run something like this: "Don't be afraid of 'system.' Your present method is a system of some sort, probably an incomplete and bad sort. If it were detailed and described in all its workings it would read quite as formidably as any modern one. Every method requires expenditure to keep it up. A modern system costs less in proportion than an old one, because its results are significant and indispensable."

THE IRON ORES OF BRITISH COLUMBIA.

By H. Mortimer Lamb.

SOME years ago, in a paper read before the Royal Colonial Institute, Dr. G. M. Dawson, then Assistant Director to the Geological Survey of Canada, referring to the large deposits of iron known to exist in British Columbia, remarked that these "wait, to realise their true importance, merely the circumstances which would render their working on a large scale remunerative." That conditions are now favourable for the development of these resources would appear from the interest that is being shown and the enquiry that is being made at the present time, by men intimately associated with the iron industry in the United States, concerning the extensive bodies of magnetite found on Vancouver and the neighbouring islands and mainland.

Although discoveries of large bodies of iron-bearing ores have been made in various localities of the Province at intervals since 1872, no annual production has much exceeded 2,000 tons, and on only one or two occasions has the aggregate output of one year reached that figure. The productive sources have been practically limited to three, or more properly speaking, two mines; one, the Glen Iron Mine, on the line of the Canadian Pacific Railway, at Cherry Bluff, near Kamloops, and the other the Puget Sound Iron Company's properties at Texada Island. In the case of the former the product has been exclusively used for fluxing purposes by the smelters at Tacoma, Revelstoke, and Nelson, while the Texada ore has been shipped to Irondale, Washington Territory, and there smelted with a mixture of from 1-9 to 3-10 of bog ore, making an excellent foundry pig, which was subsequently marketed in San Francisco and utilised, by the Union Iron Works, in the construction of the U. S. war-ships Olympia, Monterey, Charleston, and Oregon. In addition to the two mines mentioned, more or less extensive bodies of iron-bearing ores have been discovered at Sooke, Chemainus, and Barclay Sound on Vancouver

Conditions on the Pacific Coast of America afford one of the most interesting studies now open in the economics of industry. Immediately at hand are vast stores of fuel and iron—the prime elements of all manufacture. Across the Pacific are the enormous new markets of the East, which water transport is bringing nearer every week. Wherever such conditions exist, foci of industry have been created. The dawning century seems likely to witness the birth of new Clevelands, Pittsburgs, Manchesters, in the neighbourhood of Puget Sound. Mr. Lamb's article is essentially a review of some of the material bases of this new world of wealth.—The Editors.

Island; at Rivers and Knight Inlets, on the mainland coast; on the Queen Charlotte Islands, and also in several localities of the inland districts of Similkameen and Cariboo.

The Puget Sound Iron Company's property of 2,700 acres is situated on the south-west side of Texada Island. The ore-mass, which on the surface varies in width from 20 to 25 feet, is an irregular contact deposit between limestone and granite, traceable northward for nearly four miles along a ridge following the coast line, and distant from it a quarter to three-quarters of a mile. Sufficient development work has been done to expose an ore-body estimated by experts as representing 5,000,000 tons of commercially valuable iron in sight. In the course of development, at one point, copper in the form of solid pyrites was found in irregular bunches and stringers in the magnetite, but with increased depth this disappeared. Analyses of the ore have been made on several occasions in the laboratory of the Canadian Geological Survey, one result showing 68.40 per cent. of iron with only .003 per cent. of phosphorus; but a more detailed test gave:

Iron	69.85
Manganese	trace
Siliceous matter	2.75
Sulphur	.06
Phosphoric acid	trace
Moisture	trace

In a report* to the Geological Survey by Mr. Richardson, the geological features of this locality are thus described: "Three miles north-westerly from Gillies Bay, and about seventy paces from the shore, a small exposure of magnetic iron ore was met with, associated with a cross-grained epidotic rock and grey diorite. Immediately north of this exposure the ground rises steeply to about 450 feet above the sea. Here on the eastern and south-eastern slopes of the hill, for about 150 feet down and extending from 200 to 250 feet in length, is an exposure of rich magnetitic iron ore. On the outcrops facing to the north-west the ore-bed is seen to be from 20 to 25 feet thick, and to rest on grey crystalline limestone, with which, for about two feet down, are interstratified bands of ore, of from half an inch to one inch in thickness. The hill still rises to the north and north-east, but along the flank, and at about the same elevation, in a north-westerly direction for nearly a mile, the ore is occasionally seen, and in one place there is a continuous exposure of 250 feet. . . . In the concealed intervals the course of the bed appears to be indicated by a coarsely-crystalline epidotic

* Geological Survey, Canada, 1872-3.

rock, carrying ore in places, but with the grey limestones apparently overlying it to the north-east, and the grey and green dioritic rocks beneath it to the south-west. . . . In a north-easterly direction from the first noticed exposure, for a quarter of a mile, no ore is seen, after which it is again found, at first in irregular patches mixed with epidotic rocks and then, its course becoming more northerly, for more than half a mile the bed presents an irregular surface exposure of from 600 to 900 feet of nearly pure ore." Dr. Dawson in commenting on the account given of the occurrence by Mr. Richardson differs from the latter in respect to the nature of the ore-deposit, which he describes as neither a bed nor a true vein, but a contact deposit which has been produced at or near the junction of the granitic mass with the stratified rocks, and more particularly with the limestone. His reasons in support of this opinion are that near the head of the slope, where the ore has been worked, the granitic rocks are replaced by grey crystalline limestone, which occasionally becomes a nearly white marble, and at this contact the large bodies of ore are found, and appear to occupy irregular "chimneys" or interspaces of very variable dimensions. The ore penetrates to some extent not only the granitic rocks, but also the altered volcanic rocks and limestone. It frequently includes large or small epidotic kernels, together with detached fragments of the volcanic rocks, and, in some places, reticulated veins of ore are seen in the granite, forming a species of ore-breccia. The appearances are such as to indicate that the formation of the deposit occurred contemporaneously with the intrusion of the granitic mass and has been dependent on the effects produced by that intrusion, and the appearances developed since work has been carried on are such as to prove that the ore cannot be considered as a bedded deposit.

The second exposure described by Mr. Richardson is doubtless at the head of the present slope and here a shaft was sunk, and at a depth of 150 feet a crosscut driven into the mountain. After passing through dioritic rock for a distance of 187 feet, the ore-body was encountered and proved at this depth to be over a hundred feet in thickness, the ore being remarkably pure, affording 71 per cent. of metallic iron. On the north-east side of the island is a second deposit of magnetite occurring under nearly identical circumstances. The formation containing the iron ore of Texada is believed to be the same as that constituting the greater part of Vancouver and its adjacent islands.

The profitable local manufacture on a large scale of iron from these ores is not altogether a remote contingency, for, as I have previously stated, in a limited way the ore has already been turned to com-

mercial uses on the Pacific coast. Sufficiently cheap labour might be secured by the employment of Orientals, both Chinese and Japanese; an abundant supply of excellent fuel is available in the immediate vicinity; and a permanent market for the product would be assured in the industrial cities of the Pacific sea-board. A further incentive is the bounty granted by the Dominion Government on pig iron manufactured in the country from Canadian ores. On the other hand, supposing that local manufacture is not at present practicable, the coast iron deposits being, without exception, situated within easy access of deep water, transportation costs on the shipment of the crude ore to Puget Sound points would be very light, not exceeding 50 or 60 cents per ton. In addition to this charge, however, the duty of 40 cents per ton on ore imported into the United States must be considered.

On Queen Charlotte Islands clay iron-stones, the nodules varying in weight from a pound to many tons, are of frequent occurrence in the coal rocks, and might be profitably worked in conjunction with the coal seams. Magnetic iron ores of excellent grade also occur in considerable mass on these islands, to the east side of the entrance to Harriet Harbour; while remarkably pure specimens of magnetite containing 71.57 per cent, of metallic iron have been brought from an island in the Walker group.

On the mainland at Rivers Inlet, near the mouth of the Kildella river, an extensive deposit of ore is found outcropping in a contact of granite and limestone, the average of several analyses being 69.5 per cent, of metallic iron and .01 of phosphorus. A deposit, described as a vein 25 feet wide, also occurs on the north shore of West Redonda Island, in the Gulf of Georgia. The ore is a highly magnetic, somewhat finely-crystalline, granular, massive magnetite, an analysis affording the following results: metallic iron, 65.896; phosphorus, none; sulphur, .015. A small shipment of ore was made from this island some years ago, the iron being smelted in Washington Territory and converted into car wheels. Much attention has meanwhile been directed to the iron deposits of Vancouver Island. Of these the most important are the deposits at Barclay Sound, in the Alberni division, on the west coast, and the deposits in the hills to the east of Sooke Harbour, on the south coast, in the Victoria mining division.

The first exposure of iron-bearing ore in the Barclay Sound locality is met with on the mainland about a mile up the Sarita river. Here there is a considerable showing of magnetite in a contact of coarsely-crystalline limestone and diabase. The ore-body, which is said to be 80 feet wide, extends back in an easterly direction a considerable dis-

tance, the exposure having been prospected by the sinking of shallow pits and with crosscuts along its length for 800 feet. The deposit has also been partially explored by means of a tunnel, and solid ore has been encountered at a depth of about 90 feet, 60 feet from the mouth of the tunnel. In a direct line north-west by west, a continuation, apparently, of the same deposit, is exposed both on Copper Island, some two and a half miles distant, and again at Sechart, on the mainland eight miles to the north-west. Mr. Carlisle, formerly provincial mineralogist of British Columbia, examined these deposits in 1897 and described them in his annual report of that year as a ledge of magnetite lying in what appeared to be diorite* and next to a very extensive area of limestone which at the point of contact with the eruptive rock is completely crystallised into large coarse crystals. Both on Copper Island and at Sechart, the ore-body, which has the appearance of being a primary deposit, has been traced for a distance of several thousand yards, the exposures in some places having been scraped clear, giving a width of over 100 feet of magnetite of good quality. Analyses of ore from these localities have been made in England, Pittsburg, and Vancouver, the results being as follows:

	1	2	3	4	5	6
Iron	64.00	64.01	66.62	66.60	67.98	69.160
Silica	7.35	.....	2.00	.....	2.67	1.560
Alumina	0.52	.....	.....	0 14	.....	.....
Sulphur	0.0054	0.008	0.02	0.006	trace	trace
Phosphorus	0.0071	0.01	0.01	0.003	0.008	0.007
Lime	3.76	.....	4.00	.....	3 000	0.250
Manganese	trace	.....	.....	.....	0.250	0.160
Magnesia	.....	.....	.....	.....	1.150	0.120

In passing it may prove interesting to state that the rare mineral ilvaite has been discovered at the head of Barclay Sound, occuring in large irregular masses in a vein about 20 feet wide, an analysis affording the following results:

Silica	29.81
Alumina	0 16
Ferric Oxide	18.89
Ferrous Oxide	32.50
Manganous Oxide	2.22
Lime	13.82
Magnesia	0.30
Water	1.62
	99.32

Up to the present time the iron areas have been held by men un-

* This is a mistake; the rock is a diabase.

able, through lack of the necessary means, to develop them; but recently the properties in all three localities were acquired under option by capitalists of Pennsylvania, who have commenced systematic exploration and development. If these result satisfactorily the ores can be quarried out, it is stated, at a cost of about 20 cents per ton and delivered on board steel scows for an additional 30 cents or less.

The magnetic iron ores at Sooke Harbour are somewhat similar in character to those of Texada Island. The deposit, which, according to Dr. Dawson, partakes more of the nature of a stock-work than a true vein, can be distinctly traced in a north-easterly direction for over half a mile, and varies from 15 to 20 feet in width. The country rock is a coarsely-crystalline diorite containing much hornblende. Analysis of the ore made by Dr. Wallace, city analyst of Glasgow, Scotland, shows it to be of fine quality, averaging over 60 per cent. of metallic iron practically free from all impurities. As in the case of the Barclay Sound properties, comparatively little even preliminary work has been done to prove the permanency or extent of the Sooke exposures; but it is stated by an engineer who examined the deposit that the promise of an almost unlimited supply of ore is undoubted, and that with the favourable facilities for working, the ore could be mined and placed on board scows at a maximum cost of $1.00 per ton. In the same neighbourhood occurs an exposure of hematite, but the deposit is apparently not extensive.

Of the more notable occurrences of iron-bearing ore in the interior of the Province, the most important is the deposit of magnetic iron, known as the Glen Iron Mine, near Kamloops. The mass of the dioritic rock in this locality is much shattered, the cracks and interspaces being filled with the ore, which forms veins of varying degrees of thickness. The ore, which is of excellent quality, containing 66.83 per cent. of metallic iron with very little phosphorus or sulphur, is in some few places mixed to a slight degree with calcite and felspar, but not sufficiently to affect its smelting qualities. The veins, four in number, and running in an easterly and westerly direction, being nearly vertical or dipping north at wide angles, vary from 10 to 20 feet in width, and are traceable on the surface for several hundred feet. Since 1891 the annual production from this mine has been from 500 to 2,000 tons, the ore being mined and conveyed by an aerial tramway to the railway.

In 1888 Dr. Dawson reported a remarkable occurrence of magnetic iron ore about half a mile below the lower falls of the Kootenay River. The ore was found in large loose masses weighing several tons, but owing to the want of good exposure its actual relations to the rocks

APPROACHING COPPER ISLAND.

adjacent were not ascertained. The place of this occurrence is near, if not in, the line of junction of the granites with the here highly-altered rocks of the stratified series. It appeared to be associated with a dyke of green-grey augite-porphyrite and it is probable that the iron

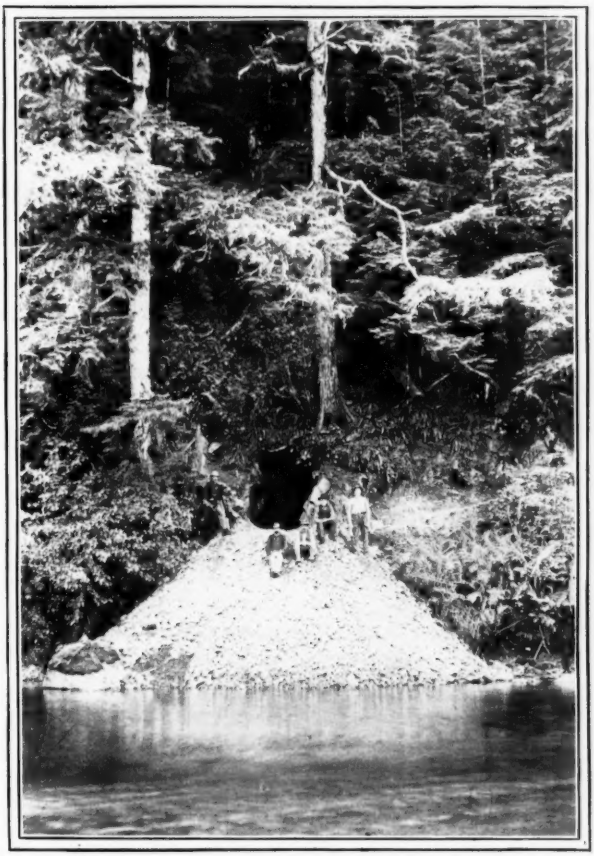
ENTRANCE TO BARCLAY SOUND, COPPER ISLAND IN THE DISTANCE.

ore when *in situ* may form irregular masses along the borders of this dyke. Another noteworthy discovery was made last year by a German geologist, a Mr. Ludloff, in the Cariboo district, of red hematite in a deposit, measuring, so he asserts, 500 feet thick. At present, however, little if any commercial value attaches to discoveries of iron in regions so far remote from railway or other means of communication as that of Fort George, on the Fraser River, the locality in which this occurrence of soft red hematite was discovered by Mr. Ludloff.

At present the extent of information available in respect to the iron deposits of British Columbia has more of a scientific than of a practically commercial interest. As exploration, however, is usually governed by practical considerations, it is probable that those deposits of which anything is known bear but a meagre relation to those of which

GLEN IRON MINE AT CHERRY BLUFF, NEAR KAMLOOPS, B. C.

nothing is as yet definitely ascertainable. It is not too much to say that British Columbia possesses enormous potential resources in her iron deposits, but that these resources must wait for commercial development upon the development of those industries which stimulate a demand for iron. Sooner or later the political reasons which led to the construction of United States battle-ships on the Pacific Coast, for which, as we have seen, British Columbia iron was partially utilised, will give place to commercial



TUNNEL AT THE SARITA MINE, BARCLAY SOUND REGION.

reasons connected with the development of trade on the Pacific necessitating the building of a large mercantile marine. Sooner or later manufacturing industries with their constant demand for the iron which is their base will be brought into being to supply the ever-increasing market of the Orient. When these things happen, British Columbia with its abundant coal and lumber in direct connection with its iron must become the seat of a great iron industry. Meanwhile these resources are chiefly attractive to those who combine in a very rare degree the gift of foresight and indomitable patience.

CENTRAL-STATION PRACTICE IN ENGLAND.

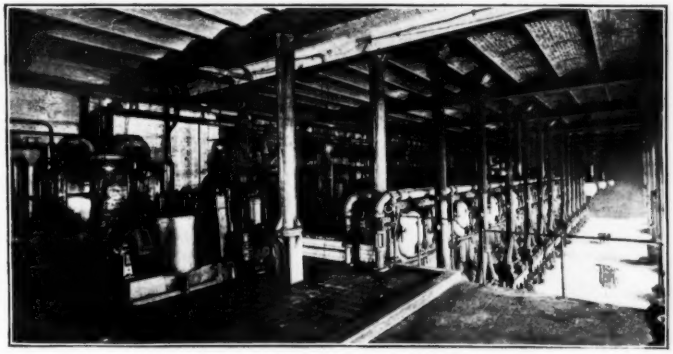
By Frank C. Perkins.

WITH the expanding use of electric power and light, the design and equipment of electric central stations occupies a constantly growing portion of the field of power engineering. International differences, springing from differences in conditions which are in part technical and in part political in their orgin, have received much attention. The subject has occupied its share of space in THE ENGINEERING MAGAZINE, and not long since typical American practice, so far as the steam end of the plant is concerned, was formulated in these pages by Mr. Hague. By way of illustrating by concrete example what has been in England, this description of the St. Luke's and Wandsworth stations of the County of London Electric Lighting Company is presented.

The site of the St. Luke's station is 303 feet 6 inches along the canal basin of the Regent Canal Company, 165 feet along Graham street parallel to the canal, 140 feet from the canal to Graham street at the northern end, and, being cut diagonally by City Road at the south end, the length along City Road to Graham street is 198 feet 9 inches. It was decided to construct the buildings within what is practically a water-tight tank, formed by thick concrete foundations overlying the whole area of the land and with water- and moisture-proof walls toward the canal, along which a coffer-dam had to be placed by the builders. The buildings, which were designed by the company's architect, Mr. F. Stanley Peach, F. R. I. B. A., in consultation with the company's engineer, are constructed throughout with best selected stock bricks and Portland cement, and the general design, so far as at present finished, is shown in the photographic views herewith.

The chimney is of square cross section with corners cut off. It is 200 feet in height, with a diameter of 12 feet at the top. The engine room is lined with glazed bricks and the floor tiled over with adamant tiles, making a very clean and neat engine room. The switch room is similarly lined with glazed bricks, and has a tiled floor. All floors throughout the building are of concrete on iron joists, the only woodwork being that used for doors and door posts, wood block floors being laid over the concrete, and the boarding for carrying the slates over the engine room.

The boiler room is 198 feet in length by 41 feet in breadth, with space at one end for a double set of economisers, above which there is a short length of flooring upon which the feed pumps are placed, as seen at the left in the illustration. From this to the present extreme north end of the building there are now installed two batteries of six boilers each, with room for a third battery of five boilers. These are fired by automatically-operating stokers, the hoppers of which are supplied with coal through vertical tubes from the coal store above.



ST. LUKE'S STATION BOILER ROOM.

In the pump-room, which is just on a level with the roadway leading off the abutments of the City Road bridge, there are placed two steam feed pumps, capable of supplying 4,000 gallons each against 150 pounds per square inch pressure, as well as two feed pumps driven by electric motors taking power from the continuous-current mains, each also capable of supplying 4,000 gallons or more per hour against the same pressure. There is a large hot-water tank into which the condensed steam from the engines is returned and in which it is freed as much as possible from any cylinder oil which may come along with it, while underneath in the feeder-ring main are two oil filters similar to those generally used on ocean steamers. From this pump-room floor short ladders lead to the platforms from which the screw-down steam valves from the boilers are manipulated. In addition to these screw-down valves, non-return valves are also inserted in the steam pipe of each boiler.

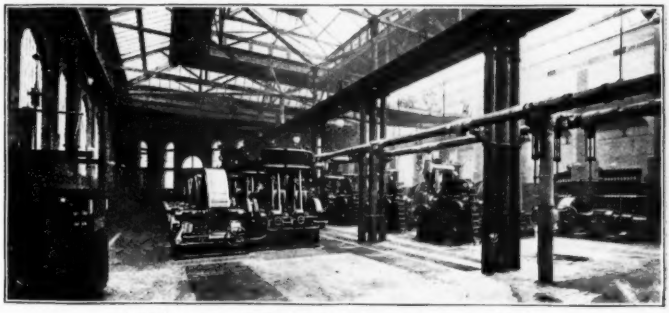
The feed-water valves of each boiler are manipulated by handles on the boiler-room floor, attached to long stems provided with universal joints. The blow-off pipes from the boilers are laid to a tank near a sump, into which any water that may percolate through the concrete

foundations drains, and when cooled in this tank, the blow-off water is lifted at present by means of a steam injector. This, however, is found to be rather wasteful of steam, and it is therefore proposed to replace it with a small motor with automatic switch operated by the rise and fall of the water in the sump.

The large amount of coal used per annum required specially large storage accommodations. The coal-storage room was built over the boiler room, and a pipe is used for conveying the coal to the boilers. To render this portion of the building fire-proof, the flooring is composed of brick arches between iron girders passing from one wall of the boiler room to the other, sheeted over with steel plates. The roof is composed of corrugated iron on steel principals and purlins. Ventilation from the boiler room below is carried out at the back of the coal bunkers by means of a box composed of steel plates, suitably supported from the wall, which carries the heated air from over the boilers and under the coal-store floor out to the roof. Ample ventilation is also provided for the coal bunkers by means of perforated iron pipes. These bunkers are divided longitudinally by a passage-way along which rails are laid, upon which rails an automatic recording weighing machine runs. The machine is so constructed that all coal, even the smallest, must be discharged on each opening of the door; it automatically records the number of times the door has been opened, and this record must correspond with the number of printed tickets of weight handed in by the trimmer at the end of each eight-hours' shift. Into the bunkers on each side (which are divided transversely by steel-plate bulkheads), the coal is conveyed by an automatic conveyor fed from the barges. A powerful hydraulic crane is stationed on the platform abutting on the end of the coal store at the edge of the wharf, the crane being fitted with a grab which, swinging round and falling at a high speed, is dropped onto the fuel in the barge and settles to its charge. The motion being reversed, the grab closes in and shuts fully loaded. The crane slews round while the grab is rising, and on the grab coming over the wrought-iron hopper fitted with spreading sides to prevent fuel splashing over, the releasing gear is operated by the crane man, and the grab deposits its contents in the hopper, which takes the impact of the fuel before it reaches the weighing mechanism. Thence the coal gently slides down into the hopper weighing machine, a self-registering automatic contrivance. The coal then having settled in the hopper, hydraulic pressure is turned on by the mast of the crane when turning round to bring up more coal, and the weighing machine slowly rises, carrying with it a weighing beam of which the outer end presses

against a spring connected with a self-recording dial. The coal being weighed and recorded, the hopper sinks back to its foundation ready for the next charge. Two folding doors operated by hydraulic rams, connected with the exhaust water from the crane, open and allow the coal to drop onto the steel-chain conveyor, which takes the fuel to the stores. As soon as the fuel has all fallen onto the conveyor the folding doors shut, and then the next charge from the grab is delivered. The conveyor is a steel chain running in a cast-iron trough, and travels up an incline from the weighing machine to the two similar conveyors running longitudinally along the coal store at a height of 12 feet from the floor. The storage room will hold 1,000 tons, and 35 tons of coal can be handled per hour. On the same floor there are two large water-storage tanks and a feed-water purifier into which water from the New River Company's mains is fed, for purification prior to storage. These tanks are connected with the feed-water tanks on the pump floor below by means of a straight pipe controlled by an automatic valve, thus providing any make-up water required.

The engine-room girders carry the two 20-ton cranes which convey any piece of machinery to or from the landing stage or its appointed place in the engine room. It was found impossible to utilize the whole



ENGINE AND GENERATOR ROOM, ST. LUKE'S STATION.

space for generating sets, and it was decided to put two landing stages on the road level, the floor of the engine room itself being at the same level as the floor of the stoke room. In the engine room there are two centrifugal pumps driven by steam engines and one motor-driven centrifugal pump for supplying circulating water, which is drawn from the canal at the southern end of the building and discharged at the northern. Close by one of the landing stages are three steam-driven exciters, two of the Electric Construction Company's make and one of the Brush Company's manufacture. There are six 200-kilowatt two-

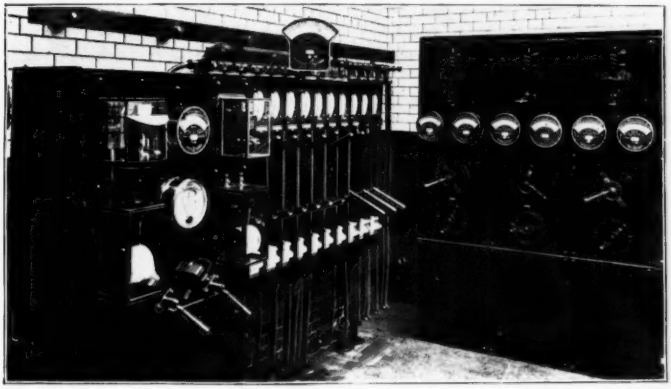
phase generators, 50 periods per second, built by the Electric Construction Company of Wolverhampton.

In the engine room there are five single-phase alternators, of the Brush company's make and of Mordey's well-known design, of 180 kilowatts each, and they can easily carry this load of 90 amperes at 2,000 volts, although originally designed for 150-kilowatt machines. The continuous-current power sets are two cross-compound engines directly coupled to 550-kilowatt generators. In this building there are also two alternating single-phase motor generators, coupled to two 75-kilowatt 530-volt direct-current machines, which have hitherto supplied the direct current for motors throughout the Clerkenwell and St. Luke's Districts. There is also a two-phase motor generator of 50 periods direct-coupled to a direct-current machine of similar voltage and output, shown at the right in the illustration. The steam pipes form a ring in the boiler room and a ring on each side of the central pillars in the engine room and are cross-fed by pipes underneath the floor, so as to have a clear way for any machinery carried by the cranes. The automatic valves are placed on exhaust pipes which run to the top of the chimney, so that the engines may exhaust either to atmosphere or through the condensers. The latter are fitted in the back standards of the engines driving the alternators, each engine being provided with its own air pump, driven by means of a lever off the low-pressure cross-head. Although the speed of these engines is 215 revolutions, a satisfactory vacuum is obtained.

The condensing water is received from the canal and is brought into two large tanks under the roadway between the chimney and City Road. A grating is provided in an aperture of the wall leading from the canal so as to strain the water before it enters the tanks, and each tank is connected with a main pipe leading round to the centrifugal pumps, where both pipes are joined together, and these are provided with suitable valves to shut off one length of pipe from the other. The tanks are also provided with sluices to shut off the water from the canal, so that the tanks may be periodically cleaned out.

The electric cranes are capable of dealing with loads up to 20 tons in weight. They are not electrically driven because, as a rule, in central stations the principal work of the crane is in assembling the various pieces of machinery, from which a supply of current is not available until after the work of erection is completed.

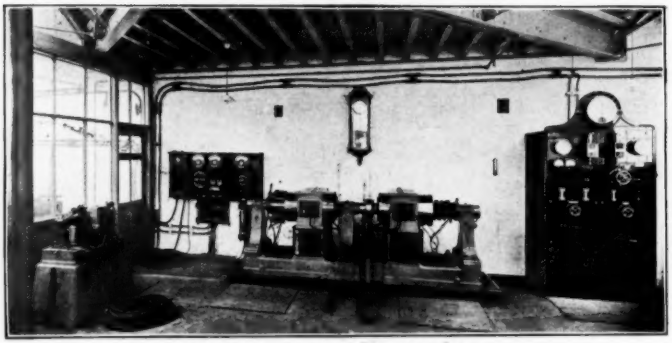
In the illustration of the engine room may be seen the switchboards for controlling the exciting current from the three main exciters, and the connections of the two small self exciters, attached to two Brush



SWITCHBOARD IN ENGINE ROOM, ST. LUKE'S STATION.

machines and with the main current to and from the exciting battery. There are also in the engine room two switchboards for the railway generators. These latter switchboards are connected by cables to the distributing power switchboard, to which are also connected three switch panels, controlling the motor generators, which may be operated either as direct-current machines, taking direct current and supplying alternating current to the mains, or vice-versa. Between these machine switch panels and the circuit panels there is a main measuring

SWITCH ROOM, ST. LUKE'S STATION.

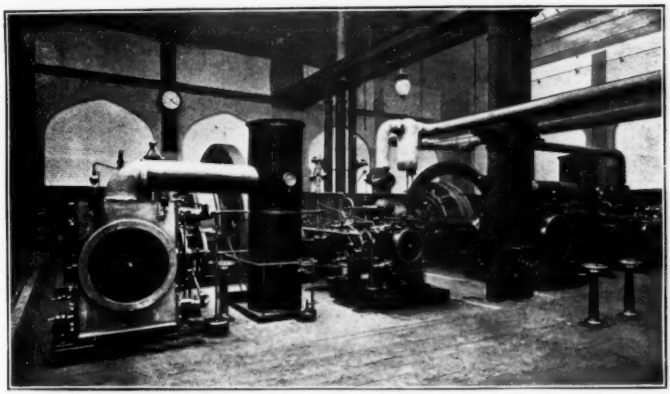


MOTOR GENERATOR AND BOOSTER, ST. LUKE'S STATION

board upon which are mounted ammeters, two Thomson integrating watt meters for light and heavy load, a recording ammeter and recording voltmeter. Beyond this latter board are ten circuit panels of Ferranti's make, also seen in this illustration.

The main alternating-current switchboards are located in the switch room and consist each of twelve switch panels, and between them is the main measuring board, upon which are mounted two sets of measuring machines, one for light and one for heavy current. At present, the board shown on the left is a single-phase board while that to the right is a two-phase board. In the center there are at present placed two instruments for recording the output of each phase of the two-phase plant and two sets of instruments for measuring and recording the output of the heavy and light load of the single-phase

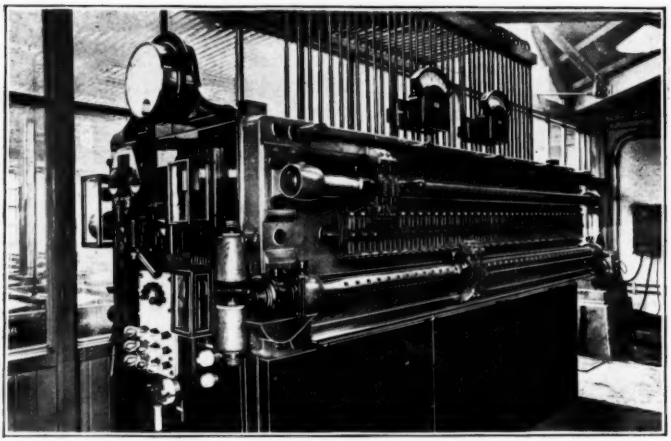
STORAGE-BATTERY ROOM, ST. LUKE'S STATION.



GENERAL ELECTRIC DIRECT-CURRENT GENERATORS AND ALLIS-CORLISS ENGINES AT ST. LUKE'S STATION.

plant. As soon as all the plant has been changed over to two-phase, both sides can be altered so that they measure and record the output of phases A and B at light and heavy loads respectively. In the background of the illustration of the switch-rooms there are two switchboards of twelve panels each for the single-phase distributing mains, supplying respectively Clerkenwell and St. Luke's. In the foreground at the right may be seen the twelve panels for the two-phase mains which supply current for the districts of Western Holborn and St. Giles. Below each of the alternating switchboards are seen the rheostats in series with the field windings of the main machines, in connection with which there is also an ammeter in each circuit. The regulation of the general voltage of the station is controlled by resistances placed on the regulating table, shown in the front of the main measuring board, and auxiliary regulation is provided by the switch pillars shown at the right and left of the table and in the rear of the switch attendant's table. These switchboards were built by Messrs. S. Z. de Ferranti & Co., while the testing instruments were furnished by Messrs. Elliot Bros.

The storage-battery room is above the landing platforms at the southern end of the building. The battery consists of 302 Tudor accumulators, having a capacity of 595 kilowatt hours, and is run in parallel with the motor generators of some of the railway generators during the day or by itself at night, for the supply of current to motors which may be then running in printing establishments, etc. The illustration on page 414 shows the booster, or motor generator to raise the



MENGARINI AUTOMATIC STORAGE BATTERY REGULATOR, ST. LUKE'S STATION

voltage sufficiently for charging, as well as a small milker for any cells which may fall "out of condition."

The switchboard, on which are double sets of terminals for charging and discharging, is provided with an automatic motor-driven arrangement for throwing in or out cells, according as the voltage on the main lines falls below or rises above the normal.

The Wandsworth Station.—Owing to the better shape of the land and the absence of the onerous restrictions imposed upon the company with regard to the St. Luke's building lines, both boiler room and engine room at this station are of more convenient oblong shape with square ends, thus avoiding any waste space as at the northern station. The main buildings are built up of best stock bricks and cement and the engine room and switch room are internally lined with glazed bricks and floored over with adamant tiles. At both stations, to prevent the hum of high-periodicity alternating machinery being too easily conveyed outside, there is an absence of windows in the side walls of the building, the engine rooms being lighted from the roofs. The chimney is 200 feet in height, of hexagon shape and of an internal diameter of 12 feet at the top. With a greater breadth of land than at St. Luke's, it was possible to erect on this site a boiler room 68 feet in width by 110 feet in length (occupying half the available site), in which the plans provided for placing a double row of boilers, their furnace ends projecting inwards, separated by a sufficient distance to allow of the withdrawal of the tubes from any boiler. On each side of

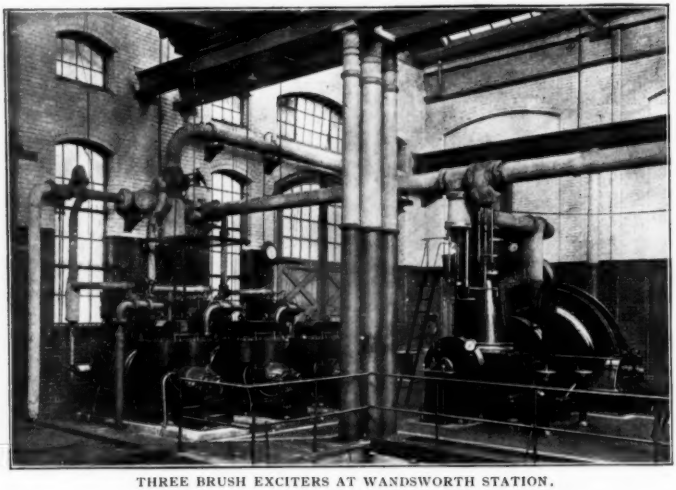
the room there is space for eight boilers with economisers and by-pass flues. One side is now fully occupied, and on the other side the foundations are already prepared for a similar equipment. Along the center space between the boilers and under the floor level, provision is made for ash-conveying gear. The boilers, as at St. Luke's, are fitted with superheaters and automatic stokers. The economisers and scrapers are driven by two small alternating-current motors.

The feed tank is of the same construction as at St. Luke's and the two steam feed pumps, also the same as at St. Luke's, are of 4,000 gallons capacity per hour each, against a pressure of 150 pounds per square inch, but provided with injectors as auxiliaries instead of motor-driven feed pumps. The coal store above is of exactly the same general construction as at St. Luke's, but of course, of larger storage capacity, as it corresponds in size with the boiler room below. The system of coal conveyance from barges to the coal store differs considerably from that adopted at the St. Luke's station, the motive power throughout being that of electricity supplied through two-phase motors of 50 periods at 200 volts; for each line of longitudinal conveyor a separate motor is provided, as well as a separate motor for the diagonal conveyor from the elevator by the weighing hopper to the end of the coal store, and separate motors for the three elevators. The lifting crane is also motor-driven. This crane is fitted, as at St. Luke's, with a grab which takes its charge and discharges its load in a

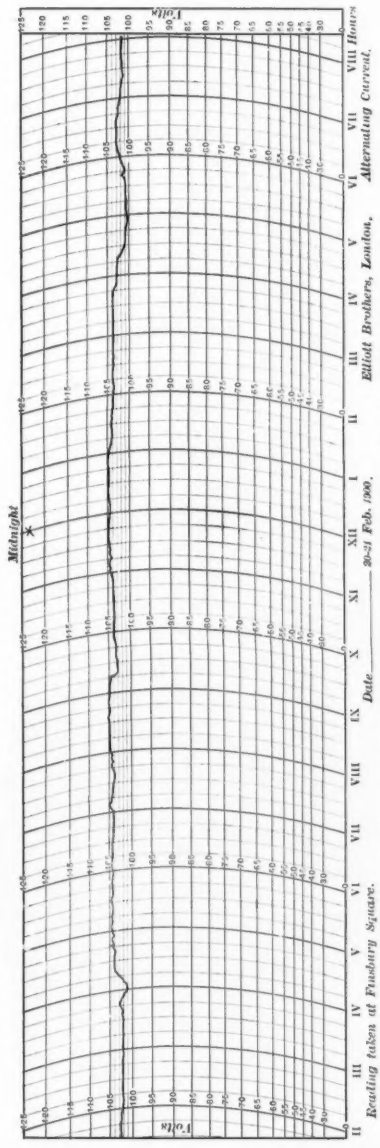
THE BOILER ROOM, WANDSWORTH STATION.

precisely similar manner, but the weighing machine is of a self-recording make, and the conveyors themselves are of the push-plate type instead of the chain type. The motors are of the Westinghouse company's manufacture. The apparatus is capable of handling 40 tons of coal per hour.

The engine room is 60 feet in width by 110 feet in length, and contains six single-phase alternating sets of 2,000-2,200 volts at 100 periods and 180-kilowatts capacity, installed on the side of engine room next to the boiler room. On the other side provision has been made for five 400-kilowatt two-phase 2,000 to 2,200-volt alternators of 50 periods, now on order, to be driven one on each side of a Mordey inductor alternator. To provide for the practical parallel working of these machines of different periodicities, and for economical working at times of light load by the use of one engine and alternator only, a motor generator has been provided as at St. Luke's. The variation in voltage as registered by the automatic recorder is shown by the curve reproduced on the opposite page. The exciting current is supplied by three continuous-current compound-wound dynamos driven by marine-type cross-compound engines fitted with electric control governors. The steam piping is similar to that of St. Luke's, save that there is no cross feeding between the ends of the building. The overhead cranes are of 20-tons capacity each. Circulating water from the Wandle comes into two separate tanks beyond the foundations (for



THREE BRUSH EXCITERS AT WANDSWORTH STATION.

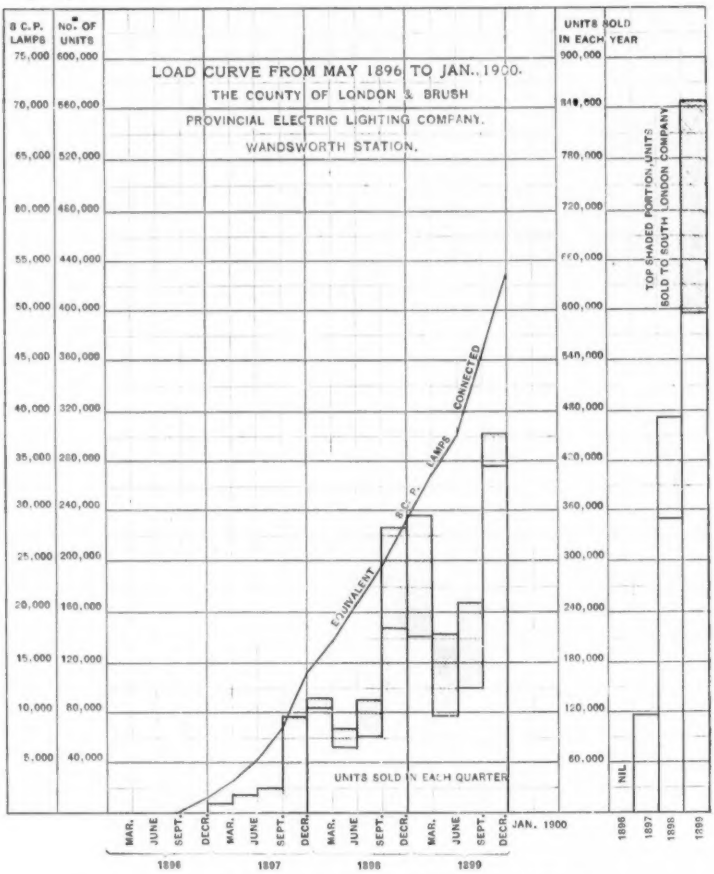


WANDSWORTH STATION. A PORTION OF THE LOAD CURVE FOR FEBRUARY 30, 1900.

future extensions) and is circulated through the engine condensers, which are placed in this case under the floor level, by means of steam-driven centrifugal pumps, one of which is spare. The air pumps are also under the floor level and are driven by a disc crank off the engine shaft. The condensed water is led off from these pumps by gravity to a tank connected with a feed pump with automatic valve, admitting of shutting off steam according to the quantity of water in the tank, which lifts the water to a feed-water tank similar to that in St. Luke's station.

As showing the extent of the area supplied from this station, it may be mentioned that while Roehampton by Richmond Park Gates on one side is distant along the route of mains from the Wandsworth station 3⅜ miles, the furthest point in Streatham still within the district of the Wandsworth Board of Works is 5¼ miles, and Clapham by way of Battersea (a long detour having to be made to avoid passing through more than was necessary of the Battersea area), is distant from the station 5⅝ miles. Camberwell Parish, however, which extends 5¼ miles from north to south and 2¼ miles from east to west,

has its extra-high-tension distributing station at a distance of no less than 10¼ miles from the Wandsworth station, and the extreme point of distribution in St. George the Martyr, Southwark, is 13¾ miles from Wandsworth, while the extreme point in St. Olave's parish is 13½ miles, and is within the comparatively short distance of 2¼ miles of the City Road station, from which, however, several geographical and especially local conditions at present prevent its obtaining a supply. The curve shows the increasing load from May, 1896, to January, 1900.



LOAD CURVE OF WANDSWORTH STATION FROM 1896 TO 1900

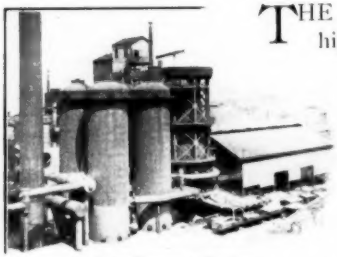
WANDSWORTH STATION.

In the Wandsworth, Camberwell and Southwark districts, the length of trenching and reinstatement to date amounts to about 75 miles. The length of pipes laid in is over 150 miles, while high-tension and extra-high-tension cable amount to nearly 50 miles and the low-tension cable to over 52 miles. With higher voltage on secondary mains, viz., 200 volts as against 100 volts on the north side, the number of transformer boxes for the much larger area is about the same as served from the City Road station, namely, 50, with three extra-high-tension converting and distributing stations above ground.

The data and photographs from which the accompanying illustrations were made were supplied by Mr. A. J. Lawson, the engineer and manager of the County of London Electric Lighting Company.

MOTIVE POWER FROM HIGH-FURNACE GASES.

By Bryan Donkin.



The Blast Furnace at Seraing.

THE idea of utilising the gases from high furnaces in internal combustion engines to produce power originated almost simultaneously in England, Belgium, and Germany. Gas engines, as is well known, have now had a life of about thirty years. They were at first driven exclusively by town or lighting gas. About twenty years ago Mr. Dowson proposed and succeeded in manufacturing a much cheaper gas from the combustion of anthracite or coke. Of this, known as power or producer gas, there are many varieties. It remained to discover that the gases from high furnaces are similar in quality, being really nothing more than ready-made, rather weak producer gas, and to apply them for the generation of power by explosion in a gas-engine cylinder. The idea was first turned to account about six years ago, and the great progress already made justifies the belief that we have here a new, cheap, and most valuable power agent.

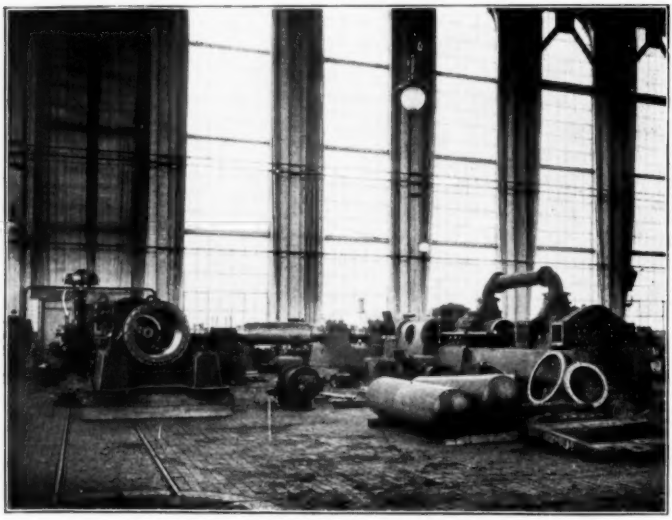
The successive steps in utilising these gases may be thus summarised: Thirty years ago they were considered of no value, and were often burnt off at the mouth of the furnaces. They were next partially used, by retaining a portion to heat the air for the blast and burning a larger proportion under boilers to generate steam for driving the blowing engines. No attempt was made to burn the gases economically, and a considerable quantity was wasted. In 1894 attempts were made in Scotland, at Wishaw, near Glasgow; at Seraing, in Belgium, and at Hörde, in Germany, to explode them in an engine cylinder, in the same way as producer gas, instead of under boilers.

The whole secret of the marvellous mechanical expansion of the past half-century is written in one word—economy. In materials, this has progressed so far that "waste products" are rarely now heard of. In the field of power, less visible but no less real wealth is still allowed to go to waste to an enormous extent; but attention is turning to some of the greatest channels of loss, and foremost among these stand the iron furnaces of the world. The development of the gas engine to the point where this huge waste can be stopped is an epoch-making event in the history of material civilisation.—THE EDITORS.

Complete success attended these pioneer efforts. It was found that, when thus utilised, the quantity required was only one-fifth of that needed when burnt under the old system, and this discovery has been very fruitful, especially in Germany and Belgium, where the subject has till now attracted much more attention than in England.

At the outset the difficulties to be overcome naturally appeared formidable and almost insuperable. To the idea as proposed to them, the ironmasters objected that the gases were too poor to be ignited in an engine cylinder, too variable in composition and pressure, that they issued from the furnaces at too high a temperature, and, above all, were so laden with dust, chiefly metallic, that they would clog the working parts of an engine. Modern science and intelligent engineers have known how to meet all these objections, and even to turn some of them to good account. The variations in composition of the gases were found to be less serious than were anticipated, and dependent upon the kind of fuel, ore, and fluxes used in the furnaces. Fluctuations in pressure were also avoided by passing the gases into a holder before sending them to the engine, and the quantity generated per ton of iron is so large that these difficulties practically disappear. For ordinary work, even a gas holder is not now considered necessary. The high temperature of the gases is also easily reduced by passing them through pipes and spraying water upon them. At Seraing they are led through vertical pipes, meeting falling sprays of cold water.

The low heating-value of high-furnace gases is due to the small proportion (about 26 per cent. or 27 per cent.) of combustible gases, chiefly CO, the rest being mostly inert nitrogen. At Wishaw the gases contain 24 per cent. CO and 27.8 per cent. of combustible gases, and at Frodingham 27 per cent. CO and 28.8 of combustible gases: thus they approach the lowest limit at which gases will ignite at all. Their heating value varies from about 95 to 126 BTU per cubic foot, but the latter was obtained at Wishaw with comparatively rich gas made with coal, whereas most blast furnaces, except in Scotland, are fired with coke. The values obtained are: Frodingham, 102 BTU per cubic foot; Seraing, 110; Hörde, 112; Differdingen, 105 BTU per cubic foot. Ordinary producer gas has a heating value of about 140 to 150 BTU, and lighting gas of 500 to 600 BTU per cubic foot Nevertheless, singular as it may appear, high-furnace gases give, in the few trials yet published, a higher thermal efficiency than either of the two other kinds, as much as 31 per cent. of the heat given to the engine having been converted at Seraing into work, as shown by the indicator diagrams. This satisfactory result is obtained in two ways.



1,000 HORSE-POWER OECHELHAUSER GAS ENGINE FOR FURNACE GAS.

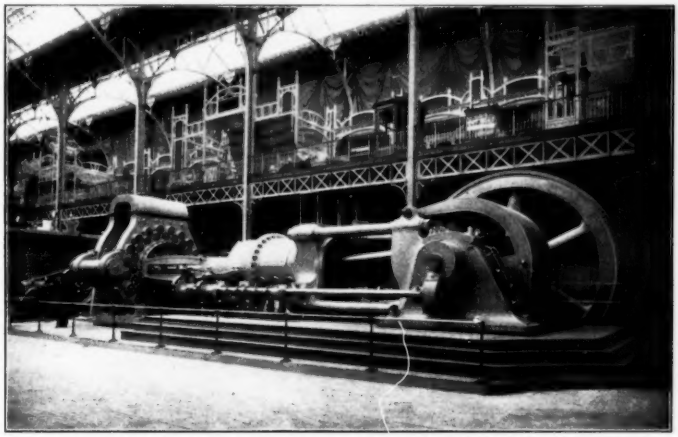
This photograph was taken, like the one on page 426, while the engine was in course of erection in the works of the builders, the Aschersiebener Maschinenbau Aktiengesellschaft. The view is taken from the blowing-cylinder end. The double-acting gas cylinder is placed between the crank shaft and the blowing cylinder, the engine being a blast-furnace blowing engine.

In the first place, the proportion of air admitted to mix with the high-furnace gases and form an explosive charge is much reduced. Before any gas can be burnt in an engine cylinder, it must, as is well known, be diluted with a given proportion of air. For lighting gas the ratio is about 8 to 1, for power gas 1.4 to 1, while with high-furnace gases the size of the air and gas valves must be so adjusted that about equal quantities of both are admitted to the cylinder. These values must be taken as only approximate, as the quality of all these gases, and therefore their heating value, varies much from time to time.

Engineers can also remedy the low heating-value of high-furnace gases in another way, namely, by compressing the charge more highly previous to ignition; it is this compression which produces the high thermal efficiency. It is now known that compression of the gaseous charge in an engine cylinder is the keynote to greater economy in working. But if gases of comparatively high heating-value, such as lighting gas, are much compressed, premature ignition frequently ensues, with all its undesirable consequences. The lower the heating value of the gas, the higher the compression it will bear without such

risk; and to this high compression blast-furnace gases lend themselves better than any other power agent yet utilised. So completely has the difficulty been overcome that no trouble has yet been found in any case in firing the charge, but in all the tests made, and in the regular work of several engines for two or three years, ignition has always been obtained with certainty.

Another, and perhaps the most important, objection to the use of these gases is the amount of dust they contain. This is still a difficulty, and requires to be met in different ways for each furnace treated, as in no two iron works are the gases exactly the same. Professor Witz, who has devoted much attention to the subject, estimates that the gases when they leave the furnace contain 125 grammes of dust per cubic metre. Of this quantity about 100 grammes are heavy metallic dust, which is deposited automatically in the pipes and passages, and collected, being usually returned to the furnaces. Nearly all the remaining 25 grammes are got rid of in the purifiers and scrubbers; about 2 to 3 grammes per cubic metre remain in the gas when it reaches the engine cylinder, and are blown out with the exhaust. At Seraing I collected some of this dust, which I found fine and soft to the touch, like flour, not gritty like sand. It is this residuum which some writers have considered so deleterious, and likely to attack the parts of the engine. This view was supported at first by Herr Lür-



THE GREAT GAS ENGINE AT THE PARIS EXPOSITION

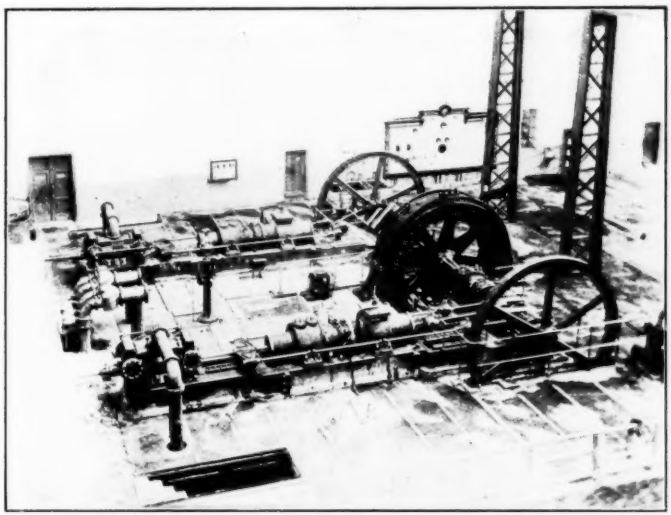
Operated with city gas 1,000 horse power, with furnace gas 650 horse power. A counterpart of the blowing engine at the Cockerill works at Seraing, Belgium. Delamare, Debouteville & Cockerill system; exhibited by the John Cockerill Works, Seraing.

mann in a paper in *Stahl und Eisen*, 1898. Several engines have now been working for some years without any trouble arising from the dust, and Herr Lürmann is now of opinion that the difficulty has been overrated, and can be overcome by the high compression exerted and high speed attained by the motor piston.

In all furnaces, however, the amount of dust the gases contain, and consequently their treatment at their exit, vary. Mr. Thwaite has proposed and patented a method of cleansing the gases electrically, by passing them through an electric field, but this hardly seems necessary except in special cases. At Wishaw the gases, as already stated, are generated from "splint" coal, and are led, on leaving the furnaces, through condensing pipes to recover the tar and ammonia. They are then passed through a scrubber and a purifier, and thence to the gas holder and engine. The usual rate of working the furnaces is one ton of coal or coke to one ton of iron melted. At Seraing the gases are comparatively poor, and contain a good deal of dust; they are washed and sometimes led through pairs of coke scrubbers, moistened with water from Koerting steam injectors. At Hörde the gas is simply passed through a scrubber and a sawdust purifier, in exactly the same way as producer gas, and no difficulty with the dust has been found at

OECHELHAUSER GAS ENGINE OF 1,900 HORSE POWER FOR FURNACE GAS.

Side view, showing one-half of the engine fully erected, the crank shaft to the right, the double-acting gas cylinder in the middle, and the blowing cylinder on the left.



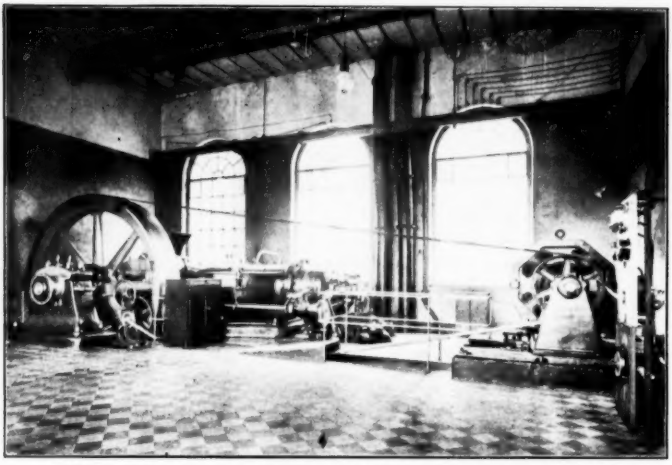
TWIN GAS ENGINES AT HÖRDE, PRUSSIA, USING FURNACE GAS

Oechelhauser engines, 600 horse power, coupled direct to electric generator at the central station of the Hörde Iron Works.

either of these places, though both have been working for some years. At Differdingen the gases are cleansed and cooled as at Hörde. Water collectors at the bottom of the scrubbers draw off the water, after washing and cooling the gases. Considerable difficulty was experienced in starting an engine at the Friedenshütte Iron Works in Upper Silesia, as the gases contained 40 per cent. of heavy zinc dust, but it was finally found possible to purify them in the usual way, by increasing the number of purifiers. By the time they reached the engine they contained practically no dust. This gas has a heating value of 106 BTU per cubic foot.

It is not surprising that such strenuous efforts should be made to overcome the difficulties in dealing with these gases, when the advantages to be derived from their utilisation are considered. Even with the present wasteful method of burning them under boilers to supply steam for the engine to blow the furnaces, it has been calculated by the best authorities that about 40 per cent. are wasted, or in other words this percentage might, if properly applied, be available as power for other purposes. But this system is very uneconomical. The chemical analysis of the gases shows that they contain a large percentage of CO, a gas of relatively little value when burnt as fuel, because of its

low heating power, but giving the best results when exploded in the cylinder of an engine. Nor has much attempt been made hitherto to use the gases economically, because the quantity generated is so large that it cannot in any case, with our present methods, be all turned to account. About 400 cubic feet are required when the gases are burnt under a boiler, to produce one horse power at the engine per hour, while according to the latest tests about 105 to 110 cubic feet are



ENGINE OPERATED BY BLAST-FURNACE GAS AT THE COCKERILL WORKS, SERAING, BELGIUM.

Delamare, Debouttevillе & Cockerill system, 200 horse power, belted to dynamo.

needed for one horse power per hour when exploded in a gas-engine cylinder. Thus the economy is as four to one, that is to say, for every horse power developed in a steam boiler and engine, four horse power could be generated in a gas engine.

We have here two sources of power at present more or less wasted, namely, the surplus store of gases going to waste in the atmosphere, after the needs of the furnaces have been supplied, and the imperfect utilisation of those now burnt under boilers, when power might be generated from them by direct combustion in a gas engine. The usual standard of working blast furnaces is about one ton of coke burnt per ton of iron made. From 160,000 to 180,000 cubic feet of high-furnace gases are produced per ton of iron smelted, or per ton of fuel burnt. This quantity may be divided into: waste, 16,000 cubic feet, or 10 per cent.; to heat the air blast, 44,800 cubic feet, or 28 per cent.; burnt under boilers, 64,000 cubic feet, or 40 per cent.; available

surplus, 35,200 cubic feet, or 22 per cent.; total, 160,000 cubic feet. Assuming that 10,000,000 tons of fuel are burnt annually in blast furnaces in Great Britain, this gives about 2,000,000 horse power wasted, which might be converted into useful work, especially for the production of electric energy. We have only to consider the immense output of pig iron per day from the high furnaces in England, the United States, and the Continent, to see how vast a store of potential energy is at present untouched. From a furnace in regular work, about 10 horse power may be obtained weekly per ton of fuel burnt.

As regards the application of this power, one difficulty has till now stood in the way, namely, the connection of the gas engines to the blowers supplying air for the furnaces. The latter work generally at about 50 to 60 strokes per minute, while an ordinary gas motor runs at a speed of about 100 to 150 revolutions per minute, according to its size, and gives its maximum efficiency at maximum speed. To adapt the speed of one to the other, several methods have been proposed. Valves of the Lang-Hörbiger and Riedler types are chiefly used, to accelerate the speed of the blowers. But this is a matter of some difficulty, and an important point now occupying the minds of those working in this direction is whether the speed of the gas engines can be diminished. This has been found more or less practicable, and in most new plants the horizontal gas engines are coupled direct to the horizontal blowers. It must be remembered that the larger the gas engine the slower the speed at which it runs. The quantity of gases generated in high furnaces is so great that the largest engines are required to utilise them. It was at first doubtful whether motors of sufficiently large size to meet the demand could be constructed. Until the discovery that high-furnace gases could be used to drive them, gas motors were seldom made in sizes above 100 horse power, or at the most 200 horse power, but a sudden impetus was given to the building of large-power engines, proving satisfactorily that their size presents no difficulty. Most of the large German and Belgian firms now make engines for work with these gases up to 1,000 horse power, or even 1,500 horse power. England is still much behind, and no large gas engines known to me are at work, although some of about 500 horse power are in hand.

It was, however, in England, that the first attempts were made to turn high-furnace gases to good account. In May, 1894, Mr. Thwaite proposed to utilise them in a gas engine, and took out a patent for their treatment. On the Continent, in Germany and Belgium, no special apparatus has been found necessary, the gases being simply drawn

off from the furnace and purified in the ordinary way, and the industry has consequently been much more largely developed in those countries. The first engine driven with high-furnace gases was a four-cycle Acmé, which was started on February, 1895, at the Wishaw Iron Works near Glasgow. Originally of 20 horse power, the engine developed 15 indicated horse power when driven with these gases, which yield as a rule only four-fifths of the power obtained with lighting gas. The engine was tested by Mr. Booth in 1896, when the consumption was about 84 cubic feet per indicated horse power, or 105 cubic feet per electrical horse power per hour, the engine being coupled to a dynamo direct. The gas was especially rich, as the furnaces were fired with coal. A small experimental plant was also put down at Frodingham, and worked well for a year or two. The consumption of this poor gas was about 110 cubic feet per indicated horse power. A more important 160 horse-power plant has been started at Barrow-in-Furness, but no details of its working are available. With the addition of a 250 Premier gas engine, which has hardly begun work as yet, these are all the motors in England, driven with high-furnace gases, as known at present.

The subject has been much more carefully and thoroughly studied abroad, and nowhere more successfully than at the important Cockerill Iron Works, at Seraing, in Belgium. This enterprising firm worked independently of the English makers, and in December, 1895, applied some of the gases from their great furnaces, of which they have six, to drive an 8 horse-power Simplex engine. The discovery that high-furnace gases could be thus utilised was made almost accidentally, while testing the Simplex motor with power gas, and it was the first engine driven with gases generated from coke. It is a four-cycle gas engine resembling the Otto, but with electric ignition, and made with only a single cylinder. The gas had a heating value (taking the water as condensed), of 110 BTU per cubic foot, and the consumption at half load was 187 cubic feet per horse-power hour.

Encouraged by this success, the Société in 1898 started a larger Simplex engine indicating from 150 to 200 horse power, and driving an air compressor, which was tested by Professor Witz in July of the same year. Of this motor, which has now been running successfully for more than two years, and which I saw at work, a view is given on page 428. It has a cylinder diameter of 31½ inches, with 39.3 inches stroke. The speed during the trial was 105 revolutions per minute. The work shown on the brake was 181 horse power; mechanical efficiency, 85 per cent.; thermal efficiency, taking the brake horse power,

20 per cent.; consumption of high-furnace gases about 116½ cubic feet per brake horse power. The result was considered so satisfactory that engines on a much larger scale were planned, and have now been started and tested. Upon this fine power plant, the largest on which trials have yet been made, experiments were carried out at the Seraing Works in the spring of this year (1900). Page 425 gives an external view of a 650 horse-power single-cylinder engine, at the Paris Exhibition, which is exactly similar to the one at Seraing on which the tests were made. As shown in the drawing, the engine is connected direct to the blowing cylinder. Diameter of the engine cylinder, 4 feet 3 inches; stroke, 4 feet 7 inches; diameter of the air cylinder, 5 feet 7 inches; stroke, 4 feet 7 inches; length of the connecting rod joining the two cylinders, 14 feet 5 inches; diameter, 11.8 inches. The experiments were carried out on two consecutive days. In the first day's trial, the engine was tested with a brake, without the blowing cylinder, and gave 573 brake horse power, with a consumption of 123.7 cubic feet of gas per brake-horse-power hour. Mechanical efficiency, 72 per cent.; thermal efficiency, taking the brake horse power, 20 per cent. On the second day the engine was coupled to the blower, and gave 886 indicated horse power and 725 brake horse power, with a gas consumption of 101 cubic feet per brake-horse-power hour. The thermal efficiency, taking the indicated horse power, was 31.5 per cent.

The Hörde Iron Works in Westphalia were the first in Germany to start a gas engine driven with high-furnace gases. In 1895 they began experiments on a 12 horse-power Otto engine, in which the consumption was 141 cubic feet of gas per brake-horse-power hour. From thence they proceeded to motors of larger size, and selected one of a new type, namely, a two-cycle Oechelhaueser for their work. In this engine there is one long horizontal cylinder with two pistons, and an air cylinder or air pump, worked from the crosshead of the back piston. The engine has no valves or cam shaft; the motor pistons compress the charge between them, and alternately uncover and close the exhaust and admission openings in the working cylinder. The cycle is as follows: A charge of fresh air is drawn into the pump, slightly compressed on one face of the pump piston, and sent on to the compression space of the motor cylinder. On the other face of the pump a mixture of gas and air is drawn in and separately compressed before it is delivered into the motor cylinder. One of the motor pistons now uncovers the exhaust port, and the other the admission ports, immediately after. The fresh charge, as it enters, is highly compressed between the two pistons as they come together, fired electrically, and

drives both out, doing work. As the air port is uncovered a little in advance of the openings for gas and air, a scavenger charge of air is first admitted, to cleanse the cylinder of the burnt products. This engine seems to be especially well-adapted for use with high-furnace gases, with which alone it has hitherto been worked, and several large plants have been ordered, including eight two-cylinder engines developing 1,000 horse power, and another of 1,000 horse power with two cylinders coupled direct to the blowers.

It is, however, on an engine of the ordinary Otto type that one of the best trials yet published has been made by Professor Meyer at Differdingen in Luxemberg, in 1898. The heating value of the gas was 105 BTU per cubic foot; diameter of the cylinder, 17 inches; stroke, 27.6 inches; average speed, 161 revolutions per minute. The engine indicated 79.5 horse power, with a consumption of 79.4 cubic feet per indicated-horse-power hour. As it was coupled direct to a dynamo, the brake horse power was determined from the electrical instruments and taken at 65.3, and the consumption of high-furnace gases per electrical horse power per hour was 96.7 cubic feet. Thermal efficiency, taking the indicated horse power, 30.2 per cent., taking the electrical horse power at 25 per cent. This is one of the most complete trials made with these gases, and the results with so comparatively small an engine are very satisfactory.

It will thus be seen that the utilisation of high-furnace gases in gas engines has been fairly started in Germany and Belgium on what can scarcely fail to be a prosperous course. Seventy gas engines coupled to blowers similar to the one shown on page 425 and now on view in Paris, have been ordered from the Société Cockerill, and motors giving an aggregate of more than 39,000 horse power have been bespoken from them and from affiliated firms. A large 1,000 horse-power plant has been furnished by the Deutz-Otto Company to the Friedenshütte Iron Works, and others are at Oberhausen and Dudelingen. The plant at the Phœnixhütte is the only one supplied from England. Since September, 1898, the Deutz-Otto firm have constructed and have now at work in Germany twelve engines and an aggregate of 2,100 horse power, while the French Société Otto are making three 600 horse-power engines. Herren Koerting, of Hannover, have also supplied a 100 brake-horse-power engine to the Donnersmarck Iron Works, which has been working successfully for a year, and they have a 600 horse-power engine in hand.

I have seen many plants running, and am of opinion that there is a great future for this work, especially for large-power gas engines.

EDITORIAL COMMENT

The practical application of new sciences gives rise to new professions, and one of importance hardly yet acknowledged is introduced by Mr. James N. Gunn, in his contribution to the special Works-Management Number of THE ENGINEERING MAGAZINE, which will form our next issue, that for January, 1901. The "Production Engineer" is the latest offspring of an epoch whose marvels are yet too new to be fully understood.

The nineteenth century, now in its closing weeks, has witnessed probably a vaster change in the physical institutions of civilisation than the whole sixty or more centuries of which we have the written records in Europe and Asia. The builder, the weaver, the farmer, the handicraftsman, the smith, worked with much the same tools and with substantially the same methods in Nineveh and Babylon, in Rome and Carthage, in old London and New Amsterdam. Progress was thought of as being in degree, not in kind. When the genius built Aladdin's palace in a night, he did it by employing countless myriads of toilers at the task. Labour spending, not labour saving, was the secret of the pyramids and of the cathedrals.

It remained for steam to break through the restraint of the ages, to shatter the old order and to give place to the new. The change was radical and revolutionary. The same functions are still needed, but they are performed by totally different organs. The steam-thresher totally rejects the mechanism of the flail. The battle-ship has hardly even a generic relation to the three-decker. The telegraph is not an evolution from the signal fire. The Oceanic is not an enlarged Mayflower; it is a distinct creature, serving the same ends not only immeasurably better, but by different means.

It needs no demonstration that so complete a revolution must go hand-in-hand with as thorough a re-ordering of methods of control and direction, and of all the co-ordinate institutions which bind the tools of production and distribution into a harmonious system. A new order of managers is needed for the new order of agencies. Similar ability is requisite, but it must be equipped with different knowledge.

This is especially true of the manufactory; it has grown in differentiation and specialisation, not in dimensions only, and its directing intelligence must meet the new conditions. The master in the early days was almost the body of his establishment, carrying out its functions personally. Later he was at least its nervous system, receiving impressions directly, transmitting them throughout the tissue of the fabric, and acting immediately upon the work-performing members. Now he must perforce be centralised as the brain, ever active while the work lives, acutely conscious of every condition, internal and external, but of necessity receiving and transmitting through intermediary means, balancing and co-ordinating the whole organisation, though the several members may be independent and almost ignorant one of the other. This means of bringing information and carrying direction—this nervous system—is as essential as the active central brain. Where it is weak the functions of the mechanical body are performed feebly, indefinitely, and often amiss; where it does not work the entire organism is paralysed and dies.

* * *

It is this vital system of sensation and transmission that is meant by the term "factory organisation," and the study of its constitution, its health, disorders,

and remedies, of its upbuilding and fostering, is comprehended in the larger science of "Works Management." The point which must be clearly understood is that the mastery of the study is not merely an aid or an advantage in gaining success in modern manufacturing; it is an absolute necessity. Factory organisation is not an auxiliary to, but an integral part of, industrial prosperity. This is the gist of Mr. Church's article in this issue (page 391), and it is a conception which cannot be too strongly urged upon works managers. The keenness of international competition is waxing every day. It is growing harder and harder for any but the fittest to survive. The gain to the world at large is enormous, for it means a constant progress in the economy of production; but the manager who does not keep up with the rush of evolution will infallibly "go to the wall."

* * *

It is to the formulated conclusions—the newly-growing literature—of this lately-recognised science that THE ENGINEERING MAGAZINE has been foremost in devoting attention. And as a summarisation of the nineteenth-century work in this field, and a basis for the advance of the twentieth century, the Magazine will devote its next issue—that for January, 1901—to the most comprehensive current review of the subject yet presented. The leaders in the thought and practice of the old world and the new will bring to this volume the best fruits of their study and labour. The themes will cover the great departments of industrial activity, the great problems which confront the manager in handling the mechanical and the human agencies he must use. The illustrations will represent the greatest establishments of the world, the most advanced practice in labour saving and labour management. It will be, in short, a text-book of plain teaching why, when, and how works organisation is to be effected—an array of concrete examples illustrating and enforcing the text. It is dedicated throughout to the practical presentation of the new applied science, "Production Engineering."

* * *

Now that the Paris exposition is over it may not be amiss to call attention to the manner in which many exhibitors wasted their opportunities. The prime object of an exposition, from the exhibitor's standpoint, is the business advantage to be gained by the presentation of his business; in other words, the advertisement he gets. In spite of this trite statement, it must be said that a majority of all the exhibitors went to large expense to install handsome exhibits to little or no commercial purpose, simply because these same exhibits were wholly or nearly wholly neglected.

In the great majority of cases, attendants at expositions are altogether unfit for the difficult task. Instead of sending men familiar with several languages, courteous and winning of manner, and thoroughly familiar with the exhibit and its commercial possibilities, it is the usual practice either to place an exhibit which has cost large sums in care of an ordinary mechanic, or a supercilious official, or, as in many cases at Paris, to leave the whole affair alone and neglected for the greater part of the time. In many instances the charge of an exhibit at an international exposition is regarded as a sort of vacation, and is given to some favoured individual who enjoys himself away from his post more often than not. Even when on duty such individuals appear to regard the inquiring visitor as a person to be snubbed, while very often any desire to investigate the construction of the exhibit is considered as an attempt to steal ideas. If all parts of an exhibit are not to be freely exposed and explained, it is incomprehensible to the ordinary mortal that it is exhibited at all.

It would doubtless cost more to place competent attendants in charge of exhibits than to leave them neglected or in the hands of the ignorant and incompetent, but it would be far wiser economy not to exhibit at all than to follow the methods of many otherwise sensible firms who might be named at Paris.

REVIEW OF THE BRITISH PRESS

The Training of Engineers.

THE subject of engineeering education will doubtless always be a fruitful question for discussion, but at the present time it appears to be attracting especial attention on both sides of the Atlantic. In several issues of *The Engineer* the matter has been discussed both editorially and in correspondence, and some interesting phases brought forward.

The chief difficulty about the matter appears to lie in the fact that many people suppose that a technical education makes a man a full-fledged engineer, capable of coping with all the practical problems of the profession. This is more than is expected of other professional lines, and more than can reasonably be asked. The student of law or of medicine is expected to devote several years to office or hospital practice before he can rightly be assumed to be capable of handling the difficult cases of independent practice. Even in engineering societies and institutions the membership classifications provide for departments of students or of junior members, lower in professional standing than full membership, and expressly intended for those who have graduated from technical institutions and schools, but who have not yet had sufficient practical experience to entitle them to the higher grade. Then, too, it must not be forgotten that engineering is a business as well as a profession, and that the business side cannot be, or rather is not, taught in technical schools. It is not enough to design machines which will work well and be economical in action; they must also be capable of being sold at a profit. Not only must the principles and methods of cost-keeping be understood, but also the equipment and operation of works, the management of men, and the commercial details of the profession. It is not meant that the engineer must personally conduct all these departments of the work, but he should know how they are done, and be competent to plan their execution and capable of harmonising the mechanical with the commercial side of the work.

These details of the engineering profession must be acquired in actual practice, but even there they are not acquired unless they are studied. In this respect again the profession is not greatly different from some others.

"The mechanical engineer without plenty of brains is certain to turn out a failure. Now, one of the special manifestations of brain power is keen watchfulness of surroundings—an appreciation of environment. To put this in somewhat different words, some men enjoy the power in going through life, of picking out and acquiring just that kind of knowledge which will subsequently be of use to them; others do not possess it at all. The able man learns something, acquires an experience in some way, and this he utilises subsequently with perhaps infinite advantage to himself; another goes through life without recognising differences, drawing deductions, or accumulating evidence. The first man is termed clever; the second is called uncomplimentary names.

"In truth, the successful mechanical engineer in the present day must turn his attention to a hundred things not dreamt of in the philosophy of the technical college. It is a matter of every-day notoriety that some firms succeed and others fail under circumstances apparently similar. Possibly it will be found on examination that there is nothing to choose between the members of the two firms, so far as mechanical skill is concerned. Our older readers will be able no doubt to call to mind, each for himself, a case in point. One firm has been able to push trade and beat competition, simply because its members possessed a special commercial aptitude which the luckless firm lacked. Unfortunately, young men training for engineers are not told these things, and only too often regard the commercial side of engineering with contempt.

We have nothing to say concerning the extravagant and careless, who cannot look after their own income, and leave parents and guardians to get them out of their difficulties. These young men have often much that is admirable, much that is desirable in their characters, but they must not complain if they do not obtain lucrative employment the moment they leave the shops. We speak now of steady, clever young men who have acquired the idea that to think of money in connection with steam engines is derogatory to science. All that, they fancy, is to be left to clerks. The cost of a steam engine is not a thing to be considered. We have met with more than one man who was disgusted to find that steam engines were made and sold at a profit, or not at all. If we have written to any purpose then it will be recognized that as matters now stand in the engineering world the pupil or apprentice must keep his eyes open, and try to learn for himself what the machinery made, more or less under his eyes, costs. He must learn the relations between plant and labour, and, in a word, waste no opportunity of learning everything that concerns the manufacture and cost of machinery. Help can be given in technical colleges. The very insistence on the fact that an engineer ought to know the price of the materials which he uses will at least serve as an awakening to a whole army of young men, or we are much mistaken."

Progress in Rapid Telegraphy.

THE rapid telegraph system of Pollak and Virag has already been described and reviewed in these columns, and it will be remembered that by its use messages can be sent over telegraph wires at a rate of more than 1,000 words a minute, a speed as high as 1,600 words per minute having been transmitted and recorded in Morse characters.

Not content with this achievement, the inventors have modified and improved the apparatus so that instead of recording the message in Morse characters the words are written in a modification of Latin script, so that they may readily be read by any one without especial knowledge of telegraphy. This is particularly valuable, as the system can be used for the rapid transmission of newspaper messages in a form ready to be sent to the printer direct, without the loss of a moment's time in transcribing.

A detailed account of the manner in which this remarkable result is attained is given in an interesting paper by Mr. C. H. Garland in recent issues of the *Electrical Review*, from which we give some extracts.

It is impracticable to give in detail the construction of the apparatus, but it will suffice to state that the original Pollak-Virag system was based upon the use of a specially constructed telephone, with optical and photographic attachments, registering the vibrations of a diaphragm thrown into motion by currents following in very rapid succession. The messages were sent by means of a perforated slip with three rows of perforations, the upper row being for guiding purposes, and the upper and lower row corresponding respectively to the dots and dashes of the Morse system.

The single telephone apparatus used in this early form of machine was only capable of elongating the light ray in a single direction. By variation of the direction of the current, the duration of the current, and the strength of the current, it was found that the waves written upon the sensitised paper by the light ray could be elongated either in a vertical or horizontal direction. By the arrangement of the perforations of the sending slip it was found possible so far to control the membrane vibrations that letters could be written in readable Latin form.

This operation involves the use of two diaphragms and two separate telephones, their vibrations being compounded upon a single mirror pivoted upon three points, one fixed and the other two movable. The perforations of the slips for the new system are necessarily more complicated than in the earlier apparatus. They are divided into two series, of which one sends the vertical components of the letters, while the other series furnishes the horizontal components. This additional complexity of the transmitting slip does not entail any difficulty, as the ribbons are prepared in such a manner that the perforations necessary to send a complete letter are made by a single impression.

The great advantage of the system, apart from its speed, lies in the fact that no

delicate and complicated synchronizing apparatus is necessary, as in other forms of writing and printing telegraphs. The objection to it is the fact that two line wires are required, although the speed is such that far greater transmitting capacity is obtained than would be possible with the same lines, wires and ordinary apparatus.

It is contended that the output of the apparatus surpasses that of any of the present multiplex type printing systems. The output of the Baudot system is reckoned at 400 messages of 10 words each per hour; of the duplex Hughes, 180 messages of the same length, while the Wheatstone, using the Morse code, and requiring subsequent transcription, is given as 2,400 messages. The Pollak-Virag system, on the contrary, can be operated at a speed of 3,000 messages, so that the output per wire is more than seven times that of the Baudot and sixteen times that of the duplex Hughes.

High Temperatures.

WE have already referred in these columns to the process of Dr. Goldschmidt, by means of which intense heat is obtained by the combustion of aluminum in the presence of a metallic oxide. The more recent practical applications of this process forms the subject of a paper recently presented before the Iron and Steel Institute by Mr. Ernest F. Lange, from which some interesting abstracts may be made. Mr. Lange's paper is based on his observations during an examination of the workings of the method at Essen, and gives especially some examples of welding by the process.

Briefly the process of producing the high temperatures is the combustion of powdered metallic aluminum with oxide of iron, together with some igniting powder; the latter consisting of barium peroxide, or a combination of nitrates or chlorates. The function of the igniting powder is simply to enable the combustion to be readily started.

After the combustion is in progress the aluminum and oxide of iron mixture may be added and the heat maintained long as may be necessary. Pyrometer experiments with the Wiborg thermophone have established the temperature reached in the operation at about 2,900 degrees C., or about 1,000 degrees C. higher than that reached during the hottest period of the Bessemer blow. The work represented by the heat energy is practically equal to that originally used for the reduction of the aluminum in the electric furnace. The resulting product of the operation is practically an artificial corundum, which can either be used as a grinding material, or sent to the electric furnace to have the aluminum reduced from it again.

The applications of this convenient process are numerous. By it the reduction of chrome and of manganese can readily be accomplished, the resulting purity of the product enabling ferro-chrome or ferro-manganese to be made free from carbon, and thus capable of use for addition to steel without altering the carbon content of the product.

One of the most practical applications of the process, however, is for welding. The operation is conducted by pressing together the two ends of the bar to be welded. There is then placed round the part to be welded, but separated from it by a fixed distance, a form made of thin iron sheeting, supported by being packed round with molding sand. The aluminum-iron-oxide combustion is then effected in a crucible of fitting size, and the contents of the crucible poured into the form. As soon as the part to be welded has taken up sufficient heat, the weld is accomplished by pressing the parts together by means of a suitable clamping arrangement. The temperature can be raised to suit the character of the work by diluting the oxide of iron with sand, magnesia or lime. Different mixtures of the material may thus be made, but it has been found that two varieties, known respectively as "Thermit P" and "Thermit R," answer all practical needs, the result being regulated also by the quantity used.

The advantages of welding by this process are similar to those existing in electric welding, with the great advantage of extreme portability. With a supply of Thermit, a sheet-iron case, a few clamps, the work can be done in the field, aloft on a skeleton structure, or below in the engine room of a vessel, no current or machinery being necessary.

Mr. Lange describes the operation of welding 7-inch girder rails, the weld tak-

ing the place of a fish joint, and providing a complete electric bond.

"A good joint having been made between the two ends, strong clamps were then secured to the rails, some 9 or 10 inches from the joint, and connected with each other by means of a strong bolt on each side of the rail. The sheet-iron form was then brought round the part to be welded, and backed round with fire clay. The reaction was then started in a crucible capable of taking 15 kilogrammes of the aluminum-iron-oxide mixture, and at the end of the reaction, which lasted about a couple of minutes, the contents of the crucible were poured into the sheet-iron form surrounding the joint, care being taken that the slag made the first contact with the cold surfaces. After waiting another couple of minutes, the rail ends were judged to be sufficiently heated, and a few turns of the nuts on the tension bolts were given equally and simultaneously and the weld effected. An important feature about this welding process is that the layer of slag or corundum which first forms round the part to be welded also protects the joint from oxidation. After the welding, the solidified mass can be knocked away by a few light blows from a hammer; but, as a rule, it is better to allow it to remain on for some time, so as to allow of a more gradual cooling of the rail joint. On knocking away the mass, it was seen that the sheet-iron form was so little damaged that it could be used over and over again."

The applications of this ingenious process are almost innumerable, and Mr. Lange does not attempt to describe many of the possibilities. One very useful one, however, is the repairing of defective steel or iron castings, such as gear wheels, and the like, by burning on additional metal at the defective place and then machining it down to the desired shape.

Priggishness in Science.

MODERN engineering has become so entirely a matter of applied science that it is to a great extent identified with scientific teaching, and hence the interest taken at the present time in technical instruction.

This demand for practical instruction appears to have encountered a decided obstacle in the form of the great army of scientific men who believe in knowledge solely for its own sake, and somehow feel as if it is degraded by practical application. We hear of pure mathematics, and pure science, these terms necessarily implying that there are forms of science and mathematics which may be considered as impure. Indeed, a German professor, in the introduction to an otherwise excellent treatise on the infinitesimal calculus, gravely stated that he objected to the use of any illustrations of rates and variables taken from such subjects as falling bodies and other physical phenomena, because they tended to introduce conceptions incompatible with the idea of pure mathematics, which should be devoid of any material connections.

Speaking of this phase of technical instruction, a paper in *The Engineer* says:

"A great deal of harm is done to technical progress in this country by scientific cant. The Royal Society represents both scientific and scientific cant. According to scientific cant nothing that is technical is scientific. Science is only concerned with phenomena, and not with their useful application. If you experiment with 37 grammes of steel in a Berlin porcelain crucible, or especially in a tiny electrical furnace, with a standardized platinum pyrometer and a spectroscope, you are doing scientific work; but if you work with a ton in a converter, this is merely technical—though you will be patronizingly told that your work may throw some light on scientific questions.

"No scientific man will deny in words that the probable ultimate use to man is the criterion of value of a scientific discovery; but all the same the tacit assumption is that anything technical is unscientific. The common type of scientific man thinks his knowledge of necessity includes all technical knowledge; but he cannot for a moment believe the technologist's knowledge may include his. The result of this sort of scientific priggishness is that technology is discouraged, and made out to be less important than it is, while unimportant work is exaggerated as to its value. Pure science, as it is called, is considered something much higher than applied science. This is the wrong way

round. The terms are misapplied to begin with. One kind of knowledge is not purer than another. What is called pure science is really merely the raw material, and the raw material has to be worked up by the engineer for the use of man. Which is higher, the raw material or the finished product? In the case of ordinary raw material, such as iron, it is produced intelligently, with the view of being worked up; that is to say, it is produced for a given purpose. The scientific man does not work intelligently in this sense. He produces raw material without knowing or caring whether it can be worked up, just as the insect produces silk. If anything, he prefers what cannot be worked up. The sperm whale sometimes produces ambergris, and also produces other matter, but we do not admire the sperm whale because he unintelligently produces what is sometimes valuable when worked up. This view of pure science is so unconventional that few readers will agree with it; but it may be largely true all the same. In France scientific cant is perhaps more rampant even than here. It is represented by the Academy of Sciences. One idea is that it is beneath the dignity of a scientific man to apply anything to technology. If he finds out a new phenomenon he should read a paper on it, but it is below his dignity to take out a patent. One form of hypocrisy in connection with this is the pretence that the scientific man works entirely for love of science. He has no wish to advertise himself or bring his name forward. If one scientific man says, in the interests of pure science, that he has done something which another man claims, there is generally a very acrimonious dispute—all in the interest of pure science, and not at all in those of advertisement. The worst of it is that the purely scientific man does not confine himself to his pure science, but considers that his knowledge covers all applied science ex officio, and the public unfortunately shares his view. This is seen clearly in the case of the Royal Society. It is absolutely non-technical, technical distinction is a bar to entering it; but when the Government wants advice on technical matters it goes to the Royal Society on the assumption it includes technology. Take, for example, the new National Physical Laboratory. Money was got from the country on the ground it was to be of commercial value. But the control is in the hands of the Royal Society, instead of the Civil Engineers' and kindred technical societies. The result will be that, instead of being of technical use, the laboratory will probably degenerate into an expensive institution for determining the value of the Clark cell to seven significant figures. The topsy-turveydom of the position of so-called pure science is nowhere more strongly shown than in the case of electric railways and observatories. The industry is hampered in many cases because its development would disturb magnetic observations, which, as far as can be seen at present, are of no value at all."

Railway Speeds.

In discussing the question of railway speeds a correspondent in a recent issue of *The Engineer* makes the very pertinent query as to why railway statistics are always reckoned in mileage and never on a time basis. The great bulk of railway expense charges are incurred on a time basis, the so-called "hourly burden," and hence time consumed is the true function of charges which vary in proportion to time.

"So long as the passenger holds a ticket he has the right to occupy the company's carriages; he has at least three of the company's servants directly waiting on him and many others indirectly; and coal is being consumed on his account." The same is true at a hotel, where the expenses are incurred on a time basis and the charges are also proportional to the duration of the stay.

Under these circumstances it hardly seems reasonable to make the charge for travel by fast trains higher than for the slower ones. The faster a train is run the sooner it reaches its destination and may be used for a return journey, and although the actual running cost of operating the fast train is somewhat greater than the slow train, yet the large proportion of fixed charges, all of them on a time basis, are proportionally reduced for the fast trains over the slow ones.

A similar state of affairs may be found with steamship lines, although more intelligently managed. There it is found that the advantage of fast liners lies in the fact

that more trips can be gotten out of them per year, while the salary lists, afloat and ashore, are not increased, and although the prices on the record breakers are somewhat higher than on the slower boats, yet the increased charges are made because of the fact that people are willing to pay more to travel quickly, rather than to any greatly increased cost of operation. The greater cost of fuel is the principal item, but this alone is not sufficient to outweigh the saving in the proportion of fixed charges.

In machine works one of the greatest advantages of piece work over the direct knowledge of the exact cost of each piece, lies in the vastly greater output per unit of fixed charge, and it is in this direction that the most intelligent efforts at cost reduction are now made. In the cost of railways the whole cost of the permanent way is a charge independent of the speed and number of trains, and the more service it can be made to bear the less each passenger should be obliged to contribute. So long as the fast trains can be made to yield more revenue the higher charges will doubtless continue to be made, but it hardly seems reasonable to charge the slow passenger less than the one who rides in the fast train when the former really costs the company more to carry him.

Insularity in Engineering Work.

In the presidential address of Professor R. H. Smith, recently delivered before the Civil and Mechanical Engineers' Society, are sounded some timely words on the necessity for Great Britain becoming aroused to the mistake of isolating herself from the rest of the world in matters relating to mechanical and engineering work.

England has so fully realised the benefits resulting from freedom in trade, so far as commercial affairs are concerned, that it is more than important that British engineers should shake off the conservatism of insularity and become aroused to the fact that they are in competition with a world of which they form only a part, concerning which they must keep themselves informed, and against which they must be prepared to contend.

Says Professor Smith:

"The restricted knowledge that the bulk of Englishmen possess of the general facts concerning other countries than their own, hinders very greatly that mutual friendly understanding which is needful as well to us as to those of other races, in order that we may successfully pursue our rivalry and competition to the benefit of both. In this respect England, I think, used to be the leader of the nations; we used to be less ignorant than any of the others were. But latterly we have confined our attention so much more tenaciously to the one object of money accumulation in individual pockets that we have not had time enough to keep ourselves acquainted with the advances that other countries have made and the change that have occurred in them.

"The extremely small number of Englishmen who have this year visited the Paris Exhibition indicates that we have largely ceased to care to learn what other people are doing. There is, in fact, an enormous quantity of interesting and beautiful improvement in detail to be learned there, but we seem indifferent to it. At the present moment very few of our home engineers have been forging ahead in the use of superheated steam in engines, nor how the constructive details of engine valve gears and engine governors have been vastly improved.

"Roughly speaking, we have no exhibits at Paris this year; at least our exhibit is microscopical to the real magnitude of our industrial productiveness. It is needless and perhaps it will be harmful, to discuss the half dozen reasons given for this almost total abstention. Admitting all these reason as facts of actual influence, the general resultant and sum total of them comes simply to this, that we consider ourselves to be so specially superior people that there is no need for us to enter into the comity of nations. It is a question of degree. I admit that we are superior; I regret that I cannot believe that we are so extraordinarily superior that this sort of thing is safe. I am filled with grave and painful apprehension that only a short delay will suffice to prove that this abstention on the part of British manufacturers from co-operation in what was the greatest effort yet made in history to demonstrate the solidarity of civilised nations, and what has been a magnificently brilliant success in this noble purpose, that our abstention has been the big-

gest mistake made these many years by the English people."

Professor Smith gives utterance to some significant words as to the future of the Chinese nation under reformed conditions, so far as technical and commercial conditions are concerned.

"In twenty, or thirty, or forty years from now, the pressure of competition will be far greater than anything to be felt in the more immediate future, because by that time, or not much later, China, under a reformed government, will be rejuvenated as Japan has been in these last three decades, and there will enter into the arena of the world's workshops the gigantic strength in numbers of the population, in natural resources of the soil, in the intelligence and hand-skill and patient laborious industry of the people, in the high intellectual quality of the cultured classes, of a brilliant civilisation, many thousands of years old, resting on the solid basis of a commercial and family morality, and of social philosophy of the finest quality.

"The philosophy of the ancient civilisation of China, which she will never abandon, in spite of temporary outbursts of violence like the present, is founded on peace and peaceful methods. It will be a struggle of wits and dexterity, not one of thunder and blunderbuss. Chinese diplomatists will fight with the weapons of reason, persuasion, urbanity and moderation. We will lose, unless we adopt the same weapons and practice to become skilful in their use."

Standardisation in Manufactures.

So much has been said about the advantages of standardisation in connection with supremacy in manufacturing, that a thoughtful editorial in a recent issue of *Engineering* is especially timely.

Standardisation is practically divided into two varieties, the particular and the general, the former pertaining to a given workshop, the latter to the whole or a portion of an industry.

In the first class naturally the conspicuous successes are found in the manufacture of patented articles of assured utility, such as the Westinghouse brake or the Willans engine, cases in which the customer must take what the manufacturer offers, there being no occasion or opportunity for modification for individual orders. The attempt to introduce such methods in a general establishment, competing for business in the open market, is altogether a different matter, demanding great courage, a stubborn will, and much constructive ability.

"To obtain either high quality or cheapness of output there must be a generous use of capital. When both are to be combined, the outlay must be still greater. If quality depended on design only, it might, in some cases, be obtained at small cost, when the head of the firm undertakes the work himself. But as business is now conducted, a great deal is required for successful manufacture beside a drawing-board and a supply of paper. There must be capable management in every department, from the first to the last, and this always commands its price. Further, the most modern and the best machinery must be employed, and much of this must be constructed for a certain end, and will of necessity be of little value for other work. It, therefore, follows that the man who would go in for standardised manufacture must lay out his works for the purpose; that is, he must stake his money on an attempt to create a special trade, with the knowledge that he may very easily lose a considerable proportion of it. Year by year it becomes increasingly difficult to develop gradually this kind of manufacture. Unless help can be gained from patents, the plunge has to be made boldly. The greater the courage, the larger the chance of success, provided always that it is associated with constructive ability and business acumen. A great business can never be made out of a poor article, although it may be realised in spite of high prices, if the goods are of sufficiently high quality. The road to success, however, lies in turning out the best goods at a moderate cost, and it is easy to understand that the route is never crowded with passengers."

General standardisation is altogether different, and is best exemplified in its most notable instance of the Whitworth screw-thread system, an example which might well stimulate imitation in the case of the pitch of change wheels, and many other obvious cases.

A great obstacle to this kind of standardisation is the consulting engineer, who dearly loves to have his individuality impressed

upon his work, even though it may not be to the customer's advantage, either in cost or utility. In fact the progress which has already been made in general standardisation has gone forward with the decline of the prestige of the consulting engineer. In the United States, where the consulting engineer has never had the influence of the profession in Great Britain, and has generally conducted work on a broader scheme, leaving details to the best practice of the manufacturer, standardisation has reached its highest pitch.

"In regard to particular standardisation, the consulting engineer in America is in general content to specify his requirements, and then to choose from among competing designs that which suits them the best. He treats manufacturers as men, leaving them to arrange the details of their business, while here they are often treated as children who must never be left for a moment free from control, lest they get into mischief. Standardisation of all kinds is the fruit of a broad and liberal spirit, which looks to ends rather than means. It is the realisation of the idea that the interests of the units are identical with the interests of the community, and that he who serves his customers, or clients, best, is most likely to further his own ends."

Modern Rolling Mills.

Among the papers presented at the recent meeting of the Iron and Steel Institute, that by Mr. Louis Katona, containing suggestions for the improvement of rolling mills, has attracted attention.

Mr. Katona gives a general history of the development of the modern rolling mill, showing how there are at present three types of mills in use, viz., pull-over, or two-high, non-reversing mills with fly wheels; three-high mills, with fly wheels; and two-high reversing mills.

In all of these certain defects appear, which are enumerated in the paper at length, but which can only be touched upon briefly here. The principal opportunities for improvement are with the consumption of power, and the waste of fuel and material. The object of the rolling mill is to reduce and control the cross section of the material, and this legitimately consumes a definite amount of power. Far more power is used, however, than is actually returned in the form of useful work effected in reducing the section of the material, and the problem is to reduce the ratio between the total amount of power consumed and that actually utilised.

The great defect of the present system of rolling-mill plant lies in the enormous masses that have to be set in motion to no effect. At any moment the only part of the mill which does useful work is the particular groove through which the metal is passing. All the power consumed in driving the rest of the mill is so much wasted energy. This includes all the power expended in the idle rolls, the couplings, the gearing, and in the fly wheel used in two and three high rolls."

It is not only the idle masses, but also the idle time, which forms a source of loss; the consumption of power when no effective work is being done continuing for more than 90 per cent. of the total running, according to observations of Mr. Katona. Besides these main sources of loss there are a number of minor ones which make up an important aggregate.

Without going too fully into the proposed improvements, for which reference must be had to the original paper, their general nature may be indicated.

Instead of using long rolls, with a number of passes in each, it is proposed to have a separate pair of rolls for each groove, the rolls thus being shortened axially so as to become mere disks. By placing a number of such mills side by side the passes may be made alternately back and forth, so that the whole series of grooves may be employed a far greater proportion of the time than when a number must be idle.

This system lends itself admirably to electric driving, enabling much of the resistance of heavy transmission gear to be avoided, while the load upon the engines may be more nearly equalised. It would also be possible under this system to work a part or the whole of the plant, as the demands of the market indicate, a far greater flexibility being attained.

Mr. Katona enumerates many advantages which he claims will result from the adoption of his system, and it is to be hoped that an early opportunity will be afforded of demonstrating its success in actual service.

Power-Gas Generation.

THE general attention which is being given to gaseous fuel at the present time is reflected in the number and extent of articles in the current technical press, and there are numerous discussions of natural gas, blast-furnace gas, producer gas, and other varieties for use both as a furnace fuel and as a source of supply for internal combustion motors. Among these papers is a valuable comparison of water gas and other combustible gases, by the well-known engineer, Herr Johann Körting, of Hanover, in recent issues of the *Zeitschrift des Vereines Deutscher Ingenieure,* from which some abstracts are given.

Herr Körting emphasises the fact that there is often confusion in speaking of various kinds of fuel gas, and that water gas is not infrequently confounded with Dowson or other producer gas, and so he is careful to note the distinction in chemical composition, as well as in the methods of making.

The difference between the two gases will plainly be seen upon examining the chemical composition. Producer gas, being generated by the incomplete combustion of carbon in the form of coal, coke, or other fuel, is composed principally of nitrogen and carbon monoxide, there being from 23 to 30 per cent. of carbon monoxide, 50 to 65 per cent. of nitrogen, with a little carbon dioxide and hydrogen. Water gas, on the contrary, being made by passing steam through incandescent coke or other fuel, contains a much larger proportion of hydrogen, the proportions ranging about 40 per cent. carbon monoxide, 50 per cent. hydrogen, 3 to 6 per cent. nitrogen, with a little carbon dioxide and marsh gas. The superior calorific value of the latter is apparent, and the commercial difference must therefore be mainly one of the cost of generation.

When the lean gas, as producer gas has often been called, can be obtained as a by-product, as in the case of blast-furnace gas, or by the use of inferior grades of fuel, as is the case in some of the more recently devised forms of producers, its low cost renders it available, especially for use in internal combustion motors, where a slight increase in size of motor, and an elevation of the cylinder compression will render equal power and higher efficiency possible over illuminating or other fuels. In other instances it may be found advantageous to generate the richer water gas, especially in view of the recent advances which have been made in the process.

The original process of making water gas consisted in using a cylindrical producer filled with coke, this being raised to incandescence by an air blast from beneath, steam being passed through the coke after a full incandescence had been secured. As the coke became cooled the steam was turned off and the air blast renewed, and so the operation continued intermittently This process naturally consumed a large portion of the coke, thus carrying away a large percentage of the calorific value of the fuel, and in spite of attempts to utilise the heat thus generated, either under boilers or in connection with regenerators, only about 40 per cent. of the calorific value of the coke appeared in the resulting gas.

Two processes have been devised which enable a higher efficiency than this to be obtained, namely the Dellwik-Fleischer and the Strache. The latter is intended to use any kind of fuel, usually coal or a mixture of coal and coke, the coal being coked in the course of the blow, the resulting producer gas passing through a regenerator which serves to increase the efficiency by conserving a portion of the heat which would otherwise be carried away. The system thus produces both water gas and producer gas, and as these are delivered separately they can be applied to appropriate uses; the producer gas may be considered as a by-product of the water gas generator.

The Dellwik-Fleischer system generates no producer gas, but aims to burn the fuel,

coke or non-bituminous coal completely to carbon dioxide, and thus utilise the greater heat developed for the decomposition of the steam. Since 1 kilogramme of carbon burned to carbon monoxide generates only 2,442 calories, while 8,080 calories are evolved by its combustion to carbon dioxide, it is evident that a higher efficiency will be secured by completing the combustion. This Dellwik accomplishes by using a much less depth of fuel in the producer, together with side charging apertures which enable the fuel bed to be maintained at a constant depth. The air pressure is also controlled so as to effect the desired combustion, and thus the full available amount of heat is obtained.

The result is an efficiency of about 75 to 80 per cent. instead of 40 to 45 per cent., and thus water gas is made available commercially where formerly the cost was prohibitory.

Herr Körting also discusses the cost and efficiency of coal gas, and finally tabulates the various commercial combustible gases, giving their relative thermal values, both from laboratory tests and from the working of existing plants, with the costs both of given volumes of gas and of thermal values resulting. The original paper must be consulted for details, but the general conclusions are as follows:

When the plant is to be used only for power generation, producer gas will not be replaced by any of the others, since it gives a more complete utilisation of the fuel, less expensive operating force, and a cheaper original plant. When high temperatures are to be produced, however, water gas holds the first place, and for many uses cannot be excelled. Especially by preheating the air blast the temperatures may be materially increased.

Herr Körting gives coal gas the precedence for illuminating purposes except in certain cases when he advocates carburetted water-gas, but his conclusions in that direction are not pertinent to the question of power generation or manufacturing purposes.

A Study of Induction Jets.

THE action of a stream to produce a current in another fluid with which it is brought in contact is a fact known and utilised in many ways and from an early period, but it is only within recent years that the theoretical and practical knowledge of this action has been perfected.

The Giffard injector was the precursor of a number of devices in which steam is employed to impel water, and similar jet apparatus is used with air acting on air, air on water, water on water, etc.

Much of the information regarding the principles involved in these devices has been kept secluded in the possession of the makers, being considered as the results of private investigation, and valuable as trade property, but we now have, in the paper of M. A. Rateau, in a recent issue of the *Revue de Mécanique*, a full theoretical treatment, which appears to harmonise well with the results of many experiments, and which should reduce the general design of such jet devices to a rational basis, removed from the domain of empiricism.

The importance of such devices is generally admitted; they extend from the minute atomizer to the great annular induction jet which forms the essential feature of the new Saccardo ventilating apparatus at the St. Gothard tunnel, with every variety of construction and dimensions between.

It is impracticable here to give the mathematical discussion of M. Rateau; for that the reader must be referred to the original paper, but some of his conclusions, and the results of his experiments, may be given. It may here be noted, however, that for his work in this direction M. Rateau has been awarded the Fourneyron prize by the Académie des Sciences.

Jet devices are composed of three distinct parts, developed to a greater or less degree in various forms: the converging tubes, or jets proper; the mixing tube, and the diffusing tube. In the first the impelling and impelled fluids are delivered, one jet usually being annular in form and encircling the other; in the second, usually a short, nearly straight tube, the two fluids unite and are mingled more or less completely; in the third the total velocity of the current issuing from the mixing tube is diminished, and partially converted into useful pressure. The diffuser is generally divergent, and separated from the mixing tube by a contracted portion, called the neck, but in many instances, as, for example, the blast nozzle

of a locomotive, the parts are not clearly defined in appearance, although existing in fact. In some forms, as in the Körting ejector, the mixing portion is composed of several successive cones, and many of the special features at first apparent in different forms of jet apparatus will be found reducible to the above three elements.

In his theoretical treatment M. Rateau confines himself to fluids which, although possibly of different densities, do not change their density during their passage through the apparatus, thus omitting steam injectors, in which the condensation of the steam makes an enormous difference in the density, because of condensation. This branch of the subject, being involved with the important question of the flow of vapors, is reserved for a later treatment.

The whole question is one of the relations of velocities to pressures, and in the formulas developed the object is to take the initial velocity of the entering jet and the mass of fluid in motion, and deduce the resultant issuing velocity, mass, and pressure.

This M. Rateau has done in a very complete manner, and he shows that in many instances the results from existing apparatus are by no means what might be attained. At the same time he shows the limitations of such devices under existing operative conditions.

According to the theory of M. Rateau, it is impossible to obtain with such devices an efficiency of more than 40 per cent., and in practice it is unusual to secure more than 25 per cent. This is largely due to a fact which has not been sufficiently appreciated, that the action of the diffuser is imperfect, rarely attaining 85 per cent. If it were possible to attain a complete efficiency of the diffuser the total efficiency of the whole apparatus would be much higher.

The experimental portion of the paper gives plotted curves of experiments made upon eleven different forms of induction jet devices, showing the general close approximation of the curves to the parabola. From these curves the point of maximum efficiency is plainly seen, and is practically reached when the initial pressure of the inducing jet is four times that of the discharge of the mingled jets. In some cases this ratio lies between four and five, varying with conditions of operation, but the former figure is more general.

The very thorough manner in which M. Rateau has worked out the theory of this interesting and practical problem causes us to express a desire that he may soon make public his researches upon steam jets, in which the condensation of the inducing fluid is an important element in the problem.

Modern Coke-Oven Systems.

In a recent issue of *Stahl und Eisen* some interesting comparisons are made of the development of by-product coke-ovens in Germany and other countries which may be noted here.

There are two principal designs in extensive use at the present time, the Semet-Solvay and the Otto systems, and it is to the progress of these that the article is mainly devoted. The growth of the by-product coke oven in recent years has been extensive. England and America are the exceptions, where the unscientific bee-hive oven still holds the pre-eminence, and but few modern ovens have been installed; but in nearly all other countries where coal is used the improved methods are making rapid progress, as, for example, in Russia, Italy, Spain, Japan, and China. The only reasons which appear to act against improvement are lack either of space or of capital.

The general principles of the by-product coke oven are well known, the coal being coked in chambers to which the heat is communicated through thin walls, while the heavy outer and division walls retain sufficient heat to prevent cooling during charging. The gases which are given off can be condensed and washed, and the liquid products also collected and separated into numerous commercial articles.

Differences in details of construction distinguish the various styles of by-product ovens, especially with regard to charging the coal, removing the coke, and applying the heat, the process being continuous, and mechanical handling being resorted to as much as possible. The heat in the escaping gases utilised for steam making by placing the steam boilers in the path leading to the chimney. A portion of the gas produced in the coking is used for heating; in the

Semet-Solvay system it is found that only about one-fourth of the gas is required for this purpose; and the interest in the application of blast-furnace gases to internal combustion motors has led to the proposal to use the richer coke oven gas also for motive power. This has been done successfully at Seraing, in Belgium, where one motor of 8 horse power has been running for some time, and two others of 20 h. p. each are under erection. The gas has a thermal value of 4,500 calories per cubic metre (about 500 B. T. U. per cubic foot) and about 0.8 cubic metre is required per horse power per hour. An interesting computation is given of the relative advantages of using the gas in gas engines and burning it under boilers. A battery of 25 ovens, producing 40,000 cubic metres of gas in 24 hours, would enable 520 h. p. to be developed in gas engines, while if burned under steam boilers the same fuel would generate only 316 h. p.

Since the introduction of the first of these ovens at Havré, in Belgium, in 1883, there have been built down to the close of 1898 1,451 ovens, which, with the 357 since under construction, brings the total up to 1,808, the locations and details of these being tabulated in the above article.

This development of by-product coke ovens is but one example of the growing tendency towards the reduction in wastes which is making itself felt in all lines of industry. In a great number of establishments valuable by-products, either tangible or intangible, are wasted when they might be converted into value and made to yield a continuous revenue. It is one of the functions of the engineer to develop methods for utilising waste wherever possible, and the pressure of modern competition is rendering such methods more necessary than ever before.

The Efficiency of Express Locomotives.

WITH the increasing use of high-speed trains, the question of the actual cost of increased speed as compared with increased income is being earnestly discussed on both sides of the Atlantic, and while all the elements of cost must necessarily be taken into account, those relating to the action of the locomotive itself appear to attract the most interest. In a recent issue of the *Zeitschrift des Oesterr. Ingenieur und Architekten Vereines* is a paper upon this subject by Herr Rolf Sanzin, and his treatment of it is especially interesting, because he examines it in view of the shortcomings of the express service of central Europe, showing in what directions steps toward improvement must be made.

The principal conditions to be fulfilled by the modern express locomotives are prompt starting, maintenance of a determinate speed for a given load and inclination of track, and capability of being quickly stopped. The first condition is met by providing sufficient boiler capacity, and also by insuring sufficient adhesion upon the rails for the driving wheels. The latter is a fundamental element in the design of the locomotive, by which the weight upon the drivers is predetermined, while slippage at starting can be largely prevented by the use of suitable sanding devices. It is also affected by the ratio between cylinder diameter and driving wheels of high-speed engines from an only within narrow limits, the larger driving wheels of high-speed engines form an obstacle to prompt starting, unless this point is well considered.

The maintenance of speed upon the road depends mainly upon the boiler capacity. When the maximum speed is stated, it is not sufficient that this be maintained upon level stretches and down grades; it must also be attained on moderate up-grades.

The control of stops is necessarily an important element in high speed running, the time used in slowing down being thus materially reduced. With this and the other two essentials must be included well constructed permanent way, with heavy rails, good ballasting, and an efficient system of signalling.

In examining the extent to which these requirements are met by the railways of central Europe, Herr Sanzin compares the speeds of trains with those of England, France, and the United States, and shows that there is manifest room for improvement. In central Europe the maximum speeds are 50 to 55 miles per hour, and these are not generally attained, while in France, England, and America the maximum speeds reach 75 to 85 miles. A part of this superiority is due to better roadbed, heavier rails, and lighter grades, but the

room for improvement in motive power is also apparent. Especially important is it that the trains should be equipped with automatic brakes of modern type, many of the continental roads being fitted now with non-automatic vacuum brakes only.

Herr Sanzin gives a number of diagrams showing the relative efficiencies of various types of locomotives, hauling trains of given weights at different speeds under varying conditions of grade, details of the engines being also fully given. For central Europe the question of grade is important, and hence especial attention is given to the limits of incline which are shown to be necessary for various speeds. Generally speaking, the maximum speed can only be attained on down grades when that maximum reaches or exceeds 75 miles per hour, and under these circumstances the maximum is about 20 per cent. higher than the mean speed. The gain by making great speed on down grades offsets to a great extent the loss due to ascending grades. This is one reason why the single-driver engine still finds favor in England, and why higher average speeds are there attained by its use than are secured by coupled locomotives in central Europe. The great problem is to maintain the highest possible average speed with but a moderate maximum speed, and this can only be done by the careful observance of all the details.

It is especially important to take advantage of the long continuous runs, and the maximum speed should be utilised wherever possible in the arrangement of the time schedule.

A most important element is the right choice of locomotives. Since the engine must be capable of coping with the ascending grades without material loss of speed, great power is required, while at the same time the ability to make high speed upon levels and down grades must not be impeded by the moving parts. These qualities, for service in central Europe, appear to be best attained by providing large boiler capacity, ample cylinder dimensions, driving wheels of moderate diameter, with a maximum weight on the drivers. Such an engine, while possibly not capable of giving the greatest maximum speed, is well adapted for the greatest average speed in a varying country under the severe conditions.

Lean Gas as a Source of Motive Power.

Among the various articles in recent technical literature, relating to the employment of gas as a source of motive power, there is worthy of especial notice a paper by M. Charles Thonet, in the *Revue Universelle des Mines.*

In discussing the subject M. Thonet devotes a moderate space to a description of the gas producers used in Switzerland and Belgium, these being simple, and not greatly different from those well-known in other countries. The gas produced is mainly composed of carbon monoxide and nitrogen, generated by delivering an insufficient quantity of air for complete combustion through a deep bed of coal in a cylindrical generator. The use of a small steam jet adds to the product of gas and gives a mixed gas partially resembling water-gas, although not so rich, while much less expensive. The composition is about 20 per cent. each of hydrogen and carbon monoxide, and 50 per cent. nitrogen, the balance being carbon dioxide and hydrocarbons; the calorific power being 1,200 to 1,300 calories per cubic metre (135 to 145 B. T. U. per cubic foot). A detailed description is given of the Fichet & Heurtey apparatus, this including scrubbers and purifiers for the mixed gas.

The principal feature discussed by M. Thornet, however, is the applicability of gas-power driving to electric stations, and comparative data are given of several French and Swiss stations, showing the marked economy of gas power over steam in many instances, especially for moderate powers.

In electric-station work the peculiar conditions must be considered, and an examination of the installation at Orleans is given as a successful example. The gas engines are of the Crossley type, with two opposing cylinders, 165 h. p. being developed by each engine, at a speed of 180 revolutions. The flywheels weigh 9 tons. The essential feature for the economical working of gas motors is that the load should vary but little, hence for such irregular loading as is found in tramway stations accumulators should be employed as equalisers. At Orleans the plant consists of two engines, each with a direct-connected dynamo, the connection being made in each case with

the Raffard coupling, consisting of two discs with projecting pins interlaced with a hemp rope. There is also a battery of accumulators, a Pirani regulator and a switchboard. The Pirani regulator is composed of two dynamos placed upon the same frame, and connected so that one acts as a generator and the other as a motor. Being placed between the main dynamos and the accumulator, they are so arranged that when the work demanded by the line corresponds to the normal load the battery neither receives nor gives out current. If at any moment there is a surplus of current the regulator adds its effect to that of the dynamos to charge the battery. If, on the contrary, the demand of the line is greater than the capacity of the dynamos, the regulator contributes, with the accumulator, to supply the line. A special rheostat enables the action to be regulated once for all. With such arrangements as adopted at Orleans the gas engines operate constantly at a load which is practically uniform, and a high degree of econmy is obtained.

M Thonet gives a table comparing the cost in coal per h. p. hour and also in actual expenditure, using for this purpose the data for steam engines obtained by M. Lanhoffer at Zürich, and assuming the price of coal at Zürich in all cases. For condensing steam engines of 200 to 500 h. p. the coal consumption may safely be taken at 2.5 to 1.5 kilogrammes (5.5 to 3.3 pounds) per kilowatt-hour, or 1.8 to 1 kilogramme (4 to 2.2 pounds) per effective horse power hour in actual working conditions. For gas engines under the same conditions, using lean producer gas of the mixed kind above described, the fuel consumption ranged from 0.65 to 0.6 kilogrammes (1.3 to 1.4 pounds) of coal per h. p. hour. Taking the cost of coal at Zürich at 32 francs per ton this works out at 0.048 franc per effective horsepower hour for a condensing steam engine, and 0.019 franc for the gas motor, the latter being less than 40 per cent. of the former.

The general comparison of the figures for the stations of Orleans, Zürich, Lausanne, and elsewhere, as discussed by M. Thonet, shows conclusively that, especially for stations of moderate size, the gas motor needs only proper conditions of installation and operation to be vastly more economical than steam power.

The Barmen-Elberfeld Railway.

THIS interesting single-rail line has been already referred to in these columns, but on the occasion of the recent formal opening of the completed section by the German Emperor, the *Zeitschrift des Vereines Deutscher Ingenieure* gives a very complete account of the whole system, which well deserves some further notice.

The line is situated in the narrow Wupper valley, which is in some places only 500 yards wide, and where the industrial cities of Barmen, Elberfeld and Vohwinkel have developed so that they form practically one community; and, although there is a steam railroad running through the valley, and also an electric railway system, the demand for increased rapid transit facilities became so great a few years ago that the cities found it necessary to build a new road.

An ordinary elevated railroad was at first thought of, but, as the conditions in the Wupper valley were peculiarly favorable for a suspended railway, the Langen monorail system, which had proved successful on an experimental road at Deutz, was finally chosen.

The crowded condition of the valley made it advisable to build the road right over the river for a greater part of the distance. The total length of the line, when completed, will be 13.3 kilometers, about 10.5 kilometers of which follows the stream from the upper end of Barmen to a point near the boundary between Elberfeld and Vohwinkel, where the Wupper makes a sharp bend. From this point the line runs along the streets of Vohwinkel to its lower terminal loop. Although the general location of the road was thus determined at the start, the detailed plan was fixed by the requirement of keeping the curvature on the main line as far as possible within a minimum radius of 90 meters, there being only two curves which have a radius of 75 meters. Tangents and curves are connected by cubical parabolic transition curves 50 meters in length.

This curvature was based upon the results obtained on three different experimental roads at Deutz; and since the completion of the Elberfeld section the experiments have been continued on a larger scale, and the earlier results confirmed. The cars run with a smoothness not hitherto at-

tained, and at curves, particularly, it is found that passengers are almost completely free from any jolting. Above all, on account of the free suspension of the cars, which permits them to assume a greater inclination from the vertical than those on ordinary roads, a much higher speed can be maintained on curves. Under ordinary circumstances, a speed of 30 kilometers per hour would be the highest permissible on 90 meter curves, while on the Elberfeld road 50 kilometers per hour is perfectly feasible. As the average interval between stations is only 700 meters, this speed is about the economical limiting one. The structure of the Elberfeld road is designed so as to permit the cars to swing out at an inclination of 15°, but on the experimental road at Dentz, on 9½ meter curves, cars were inclined at an angle of 25° without the occupants being at all aware of their peculiar position, the shades on the windows having been drawn down.

The Wupper falls 25 meters in the 10.5 kilometers, for which it runs under the suspended road, and the grade of the latter is, in general, parallel with the surface of the stream. The height of the road varies somewhat, however, as it has to be increased at some street crossings and bridges, and is made as low as possible at stations. When the line leaves the river it ascends a nearly uniform grade, rising about 48 meters in 2.8 kilometers, the steepest inclination being 1 to 37. On the sidings, however, there are grades as high as 1 to 22.

The lower edge of the cars is 3.5 meters below the top of the rail, and as the car must clear the street by 4.5 meters, the rail must be at least 8 meters above street level.

There are 20 stations on the line, the interval between them varying from 320 to 1,000 meters. At the terminal stations there are loops, so that the trains can circulate continuously up and down the main line, which is double track, without switching. The heaviest traffic will be in Barmen and Elberfeld, so that only some of the trains will run all the way to Vohwinkel. There is, therefore, an intermediate loop, passing under the main tracks, at the lower end of Elberfeld, to accommodate the trains which run only in that city and Barmen.

The road is carried by trusses of special design, with spans varying from 33 to 21 meters. On the river section the trusses rest on plate girders connecting the upper ends of inclined latticed columns, which abut against masonry foundations in the banks, while over the highways the trusses are supported on plate girder arches continuous with plate columns. The rails are carried on the outer part of the lower chords, with an interposing layer of felt to prevent shock and noise.

The weight of the trusses varies from 580 kilograms per meter (390 pounds per foot) for the 21 meter spans, to 786 kilograms per meter (528 pounds per foot) for the 33 meter spans, while only 142 kilograms per meter (95 pounds per foot) has to be added for tracks and flooring. The average weight of the whole structure, including the columns, is about 1,100 kilograms per minute (740 pounds per foot), the river and highway sections agreeing very well in this respect. The rails are T-section, 15 meters long, and weigh 24 kilograms per meter (16 pounds per foot). The weight of the whole superstructure is 31 kilograms per meter (21 pounds per foot).

As the car-wheels are double-flanged, the switches have to be of peculiar construction. The main track is continuous throughout the line, and at switches the point gradually rises to an elevation of 75 millimeters above the through rail, so that the wheel flanges will clear the latter. The track curvature at switch points has a radius of 8 meters, and the sidings, which are situated at the loops and terminals, drop below the level of the main track.

At stations the tracks and platforms are completely roofed over, and among the special features is a beam running along outside the edge of the platform, with a surface corresponding with the under body of the cars. A spring on the car slides along this beam and prevents any rocking while passengers are entering and leaving.

The total weight of metal used in the construction of the whole road, including stations and car-houses, is 18,000 metric tons (20,000 short tons). The cars are suspended from two trucks, 8 meters apart, each with two wheels. The heavy hook-shaped frames connecting the trucks and cars embrace the track-supporting beams in such a way that, with the deep wheel flanges, derailment is impossible, but so as

to permit the cars to swing 15° from the vertical.

On each truck is an electric motor, which drives both wheels. Current is taken from a light rail by means of a sliding shoe. When two or more cars are coupled together, all the motors are controlled from the first car, which alone has its sliding shoes in contact with the conducting rail. The current in this case is led to the other cars through connecting flexible cables.

The cars are provided with Westinghouse air brakes, which are used in ordinary operation, the compressed-air tanks being filled at the terminal stations. The motors are used for electric braking when beginning to slow down before stations, and in case of emergency there are also hand brakes.

An automatic electric block-signal system is in operation, the necessary contacts being made by the trains themselves. The signals are red and green electric lights, which are used by day as well as by night. At present the 4.5-kilometer Elberfeld section is in operation, the 3-kilometer Vohwinkel section will be opened in the course of the coming winter, while the 6-kilometer Barmen section will probably not be completed before 1902.

Rescue Apparatus in Mining.

WHENEVER explosions occur in mines or tunnels, or noxious gases make their appearance, it becomes of pressing importance to enter the dangerous regions at once and rescue any persons who may have been injured or overcome, and also to repair damages and take measures to prevent further trouble. It is necessary, of course, to provide anybody entering such a mine with a supply of fresh air, or oxygen, and a recent number of the *Oesterreichische Zeitschrift für Berg-und Hüttenwesen* contains a review, by General Johann von Lauer, of various forms of respiratory apparatus which have been used, particularly in military mining.

In some of the earlier forms, a cylinder of compressed air was carried on the miner's back, the air being led through a regulating valve and tube to a hood which completely covered the miner's head, and, in some cases, extended to his waist. This hood, or mask, had eye-holes covered with glass, and a valve to permit the escape of the exhaled air. In a modification of this apparatus two air tanks were carried on a two-wheeled barrow, one to supply air for breathing, the other air for a lamp or candle. At the same time, the barrow could be used to carry out disabled persons.

These earlier forms, however, had the disadvantage of furnishing only a very limited supply of air, unless air reservoirs were made large and cumbersome, and in the more recent apparatus the tanks have been entirely dispensed with, and air is pumped to the miner from outside through a long tube, very much in the same way that air is supplied to divers. A plate fits over the mouth, and is provided with rubber cushions which can be inflated so as to press firmly against the face and prevent any ingress of noxious gases. The air tube passes through this plate, and all the breathing is done through the mouth, the nostrils being clamped shut. A valve allows the escape of exhaled air. If gases or vapors injurious to the eyes are present, air-tight goggles are used.

Light is supplied by an electric incandescent lamp, fed with current through a thin silk cable. The source of current may be either a dynamo, or, preferably, a portable primary battery. The battery box has attached to it an electric bell, on which signals are rung by the miner by means of a key inserted in the lighting circuit and carried on his belt.

This last described apparatus has proven very successful in military mining, and experience with it has shown that no essential modifications are necessary.

REVIEW OF THE AMERICAN PRESS

Steam Engineering in the American Navy.

THE report of Rear-Admiral Melville, Engineer-in-Chief of the United States Navy, forms a most interesting and valuable document, and no excuse is necessary for copious extracts from so important a public paper.

A large portion of the report is naturally devoted to routine business and to statements of the operation of the current work of the Bureau of Steam Engineering, but with this are important recommendations and discussion of future policy. One of the most important problems before such a department is the necessity for keeping abreast with the march of improvement, while at the same time avoiding experimental innovations which might possibly hamper the efficiency of the service or possibly cripple it in time of emergency.

"One point in particular will illustrate the extreme value of high professional criticism in design. Some years ago the Department was urged, with no little pressure, to adopt the Belleville water-tube boiler as a standard for the new ships. This Bureau opposed the innovation wholly upon a close examination of the designs, criticising the very defective features which in later years have made conspicuous the comparative inefficiency of this type over the purely straight-tube, non screw-joint type for which I have given continuous and urgent preference. The Department is to be congratulated upon escape from this "pressure" and upon the conservative approval it has given to the change in the boilers of naval ships. Instead of having been encumbered during the last war with ships powered with a type of boiler necessitating a specially trained force even for its safe operation, the most effective vessels had either retained the Scotch boiler or possessed the simple straight-tube Babcock & Wilcox boiler and remained free from any real danger of becoming 'hors du combat' by reason of lack of a completely experienced fire-room management, or the sudden failure of delicate or intricate special apparatus connected with the steam generators.

"In many other details, difficult to make clear without purely technical description, has the Bureau prevented the incorporation of faulty features in design and has advanced the proportional perfection of machinery."

There has been active work upon various problems in steam engineering which needs to be supplemented by experimental demonstration, not so much to confirm the accuracy of the conclusions as to determine proportions and practical details. One of the most important of these problems is in connection with a radical change from the present standard for cylinder ratios in multiple-expansion engines, a subject which has also received much attention in stationary practice. Engineers in all departments of practice would welcome the results of such experiments and join in urging that they be conducted.

The great advantages of the presence of a repair ship with a fleet were demonstrated by the work of the Vulcan during the Spanish-American war, and the reverse experience has been had in Eastern waters in the absence of such a vessel. The repair work done at Manila and Hongkong has been so unsatisfactory that Admiral Melville is fully justified in his recommendation that a special repair ship be built and equipped. With the experience gained on the Vulcan it is possible to plan the requirements of such a vessel very fully, and it is to be hoped that this recommendation may speedily be executed.

The efforts of those interested in the assumed superiority of the line over the staff officers under the old rule, to effect a consolidation of the bureaus of Construction and Repair, Steam Engineering, and Equipment, into one Bureau of Ships, this new Bureau, of course, to be dominated by a line officer, meets with some telling strict-

ures from Admiral Melville. After showing that the whole tendency of modern work is toward specialization rather than to centralization, he pertinently remarks that there is already such a Bureau of Ships, but that it is really the whole Navy Department, and that its Chief is the Secretary of the Navy. The present arrangement, whereby the Secretary of the Navy is advised by the Board of Construction, has proved eminently satisfactory, except to those who view with dissatisfaction the necessarily increasing importance of the Engineer Corps, and there is no valid reason whatever for the proposed change.

So far as the operation of the personnel bill is concerned, it is only what might have been expected under the present influences. Not until the line officers, below navigators, are given as much duty in the engine room as on deck, will the true meaning of that bill be appreciated, and the spirit which seeks to avoid such an obvious duty utters its own condemnation. The younger line officers should be assigned as understudies and assistants to the experienced engineers now in charge of engineering work. In other words, it is most important that the fact should be realized that a modern fleet is a vast aggregation of machinery, and that it should be run by engineers and not by sailors. Sea power is too important a factor in national existence to be hampered by the old-fogyism which retains obsolete training in so-called seamanship and neglects the true basis of modern fleets, the fighting machinery. In recommending the detail of a modern vessel for a practice ship at the Naval Academy, Admiral Melville says:

"It seems to me that some of the time still devoted by the Academy cadets to seamanship, in the original sense of the term, may be wisely sacrified to steam engineering, and that anomalous vessels for practice cruises can be safely exchanged for a modern type of war ship. Smokestacks have replaced topsails and top-hamper, and the officer of the deck finds more need of skill in quick manœuvre than in handling canvas aloft."

In discussing the difference between the work of a naval machinist and a naval engineer, Admiral Melville gives an excellent description of what the naval engineer should be, and what he must be if the navy is to keep pace with the development with the conditions in which it is now called to act.

"The naval engineer of to-day must be one not only specially qualified by aptitude for his profession, and secure in a thorough technical education, in which the theories governing his later work are firmly implanted in his mind, but he must also have had actual practical experience in the different mechanical branches of his calling, gained in such a favored way as to give him intimate knowledge of the prevailing methods of work without inflicting that long apprenticeship which binds the ordinary mechanic who must pay for his training by his actual output, and whose future employment must greatly depend on manual skill. Thus years are saved in the progress possible, and extensive knowledge of designs, with immediate practice in the embodiment of these in actual work, is obtained. Thence comes the experience gained on shipboard with machinery under all conditions of service, and the observations of the machinery of foreign ships and the work at ship-building establishments ashore. These experiences are only obtainable, in their full extent, by the naval officer, to whom every courtesy is extended by his professional brethren at home and abroad. Both his position aboard ship and his comparative freedom from confining detail work enables the naval engineer to broaden his professional education by the comparison of the designs and operation of machinery of different classes of ships. It also permits him to keep posted in advanced shop practice and in current engineering literature, thereby enabling him to keep out of the 'hide-binding' grooves worn by a narrower class. So much is necessary to continually study and apply, as to make a leading position in this profession only possible to one with exceptional opportunities and surroundings. Hence it is not lack of native ability, but environment and training, which precludes the possibility of simply advancing the machinist class to that of the efficient naval engineer."

Foundry Traveling Cranes.

In a paper recently presented before the Pittsburg Foundrymen's Association by Mr. A. D. Williams, some pertinent remarks are

made upon the use of electric traveling cranes for foundry service.

The general use of the multimotor electric crane at the present time renders it desirable to learn the practical points which have developed with the use of motors in the peculiar conditions of foundry service, and Mr. Williams evidently writes from the standpoint of the practical foundryman.

Apart from details of construction, which have become fairly well standardized and established, the most important matter is accessibility and ready removal of parts. Armatures and commutators, parts most liable to injury, should be capable of ready removal, as repairs can be much more readily made, and it is advisable to have spare parts which can be substituted, so that the service of the crane may not be interrupted.

An important feature in electric cranes, especially for foundry service, is the lowering gear. In the best forms of construction the brake is so arranged that the tendency of the load to run down acts to set the brake. In lowering, the motor acts against the tendency of the load to lock the brake, and the load cannot move until these two forces balance each other. This is a very safe device, and satisfactory when well made, but it sometimes acts in a jerky fashion, developing strains in the structure, and possibly damaging the mold.

The difficult conditions with which crane makers have to contend are often responsible for unsatisfactory forms of construction. In order to obtain the maximum amount of trolley travel a short trolley is demanded; the maximum amount of hoist requires that the trolley shall be placed close to the roof chords; and when these requirements have to be met in an old foundry, the ingenuity of the crane builder is often severely taxed.

In order to prevent overrunning, either in hoisting or in bridge travel, safety devices are often employed, but the utility is questionable, as they may usually be evaded by ingenious operators, and it is better to have the crane in charge of a responsible man, who will be careful at all times.

The usual provision for keeping the crane bridge square upon the tracks is by a so-called "squaring shaft" transmitting the power of the motor positively to both ends of the bridge alike. It is hardly necessary to observe that this involves truck wheels of the same circumference, and it is also necessary that the shaft should be much larger than the mere working stresses indicate, as stiffness and rigidity are essential. In some of the earlier types the motor was placed at one end of this shaft, with the result that the torsion of the shaft caused the bridge to get out of square. By using a stiff shaft and placing the motor in the middle of its length, good results are secured.

The crane girders should be braced laterally, either by some form of lattice bracing, or by being made of the box type; the former is preferable, as the box girder cannot be painted inside. Provision should be made for climbing about the crane, as repairs are often delayed by the difficult position in which the men must work.

Mr. Williams calls attention to the importance of reinforcing the service of a traveling crane by providing a number of light jib or post cranes along the sides of the foundry, in order that the time of the heavy machine may not be wasted with small work while important matters are delayed. When a foundry is thus equipped it will be found that there is a great saving in labor, and a far greater output from the skilled men, to the manifest advantage of the whole establishment.

Heat and Power from Furnace Gases.

Now that there is no longer any doubt about the fact of the practical utilization of the discharge gases of blast furnaces for motive power, the subject begins to assume a quantitative, instead of a qualitative, aspect, and hence the paper of Mr. F. W. Gordon, in a recent issue of the *Iron Age*, is of much interest. Mr. Gordon takes up the question from the side of the thermal reactions, striking a balance between the thermal units supplied in the fuel, and those consumed in the reduction of the iron, the remainder being more or less available for the production of power, according to the efficiency of the process.

Taking data from earlier papers based upon investigations at South Chicago, made several years ago, Mr. Gordon assumes the consumption of 1,862 pounds of coke per ton of pig iron to be a fair quantity, and

proceeds to compute what amount of heat should be used by the furnace, and how much would remain available for other purposes.

Basing the completeness of the combustion upon the composition of the discharge gases, Mr. Gordon computes in detail that the total heat of the consumed gases is 7,889.93 B. T. U. Deducting from this the heat necessarily lost in chimney gases, radiation, and convection from stoves and boilers, the actual available heat is given as 5,986.74 B. T. U., this being an efficiency for the stoves and boilers of 75.75 per cent. Of this heat a certain amount is required by the furnace, and computations are given for the heat used for heating the blast, driving the blowing engines, hoisting the material, and pumping water, these items adding up a total of 2,220.94 B. T. U., leaving a balance of 3,765.8 B. T. U. that may be used elsewhere, and showing that only 37.1 per cent. is used by the furnace.

Mr. Gordon, in all his computations, assumes that the gases are burned under boilers to generate steam, and he proceeds to show the economies which may, in his opinion, be effected in this department.

In the case of a 300 ton blast furnace, the power not required by the furnace and available for other purposes is 4,223.8 horse power, and assuming engines consuming 1.8 pounds of coal per horse power hour, with coal at $2.00 per ton, the fuel value of the waste gases is equal to $61,095 per annum.

"The failure to derive any great advantage from the excess of heat in the blast furnace is due to lack of appreciation of its value. The subject has not been followed up. If furnace owners believed that with day and night use of the gas from a 300 ton furnace, coal at the rate mentioned could be saved, worth $60,000 in one year, the subject would receive attention.

"That perhaps every engine in the steel plant can be run from the furnace boilers, together with the blowing engines, pumps, etc., of the furnace, while enough gas is diverted for heating the blast, will not be taken for granted. But with good combustion, ample stove surface, that their chimney gas may be kept at a low average temperature; with well-set boilers of ample surface, carefully tended and cleaned inside and outside; with blowing engines developing in compressed air the equivalent of 10 per cent. of the heat of the gases burned to raise the steam these engines consume, and with the surplus steam economically distributed and used, the total steam work of a steel plant may be done without burning any coal for steam, while the furnaces are working well."

If such results can be obtained with steam plant, the engines having a maximum thermal efficiency of only 15 per cent., what can be done with the direct use of the gas in internal combustion engines? This question is not discussed by Mr. Gordon, but it can easily be computed when it is realized that the thermal efficiency of the internal combustion engine for lean gas may safely be taken at 30 per cent., instead of the 15 per cent. efficiency of the steam engine.

Undoubtedly the iron and steel works of the future will have few or no steam engines. Gas-driven blowing engines will provide the blast; central power plants containing large gas engines directly connected to electric generators will provide light and power for distribution to all parts of the works; the rolling mills will be electrically driven, as will all the other machinery, and there will be a surplus for outside use which may yield a revenue as great as that obtainable from the iron manufactured.

The Reaction Breakwater.

THE subject of the improvement of the Southwest Pass of the mouth of the Mississippi was briefly mentioned in the last issue of the Magazine, with especial reference to the jetty system proposed by the government Board of Engineers.

Another plan, worthy of careful attention, is the so-called reaction breakwater, advocated by Professor Lewis M. Haupt, which appears to be especially well adapted to this important case. The reaction breakwater, the example of which at Aransas Pass has been fully discussed in these columns, is really a device to utilize the well-known tendency of a channel to hug the concave bank of a bend, the action of the curature being to produce a scour due to the concentration of the currents. In a recent issue of the *Journal of the Franklin Institute* the applicability of this construction, long ably advocated by Professor Haupt, to the Southwest Pass, is discussed and some

interesting points brought out. The matter is also the subject of correspondence in recent issues of the *Engineering News*, in which the advantages of the single reaction jetty over the proposed pair of straight jetties of the government Board are emphasized.

Professor Haupt's plan, which has been elaborated with care for the particular case under consideration, involves the construction of a jetty starting from East Point and extending nearly 2 miles in almost a straight line parallel with the axis of flow and at a proper distance from it, thence curving to the westward with a radius of about 4.64 miles for a little more than 2 miles and ending at the 30-foot outer contour.

The portion of the area of discharge which would be cut out by this jetty is 115,750 square feet, or 66 per cent., which deducted from the total area would leave 59,375 square feet, or less than the normal section, but as the work would require several years to build and the volume of the movement would be confined to the overflow following the line of the jetty, the formation of the channel would be local, permanent and rapid. The 15,000 square feet of water section on the west flats would ultimately partially fill up and thus assist in confining the currents to the channel.

The inability of two straight, parallel jetties to create and maintain a deep channel is obvious upon the examination of the conditions, and this is practically admitted when it is proposed to supplement their action by dredging some 22,000,000 cubic yards of silt from the bar. The ultimate action of straight parallel jetties is to transfer the conditions to a point further out, recreating conditions at the mouth similar to those occurring in a state of nature. The jetties, acting as an aqueduct, must transport all the river sediment through the canalized channel and dump it into the sea at its mouth, and unless there is a strong littoral current the external forces are unable to distribute the material, and dredging must be constantly employed.

The single curved jetty, on the contrary, produces a reaction and scour across the entire bar, displacing the material in a lateral direction and depositing the silt on the opposite bank of the channel, where it automatically forms a natural levee, adjusting itself to the regimen of the stream.

The correctness of this reasoning is demonstrated by the success which has attended the construction of such a curved breakwater at Aransas Pass, Texas. Here there is no stream to effect the scour, and dependence must be placed entirely upon the moderate current produced by the action of the tides. Notwithstanding this there has been produced in five years, without dredging, a continuous depth of 15 feet at mean low water, with maximum depths of 25 feet. The formation of a natural spit on the convex side of the breakwater effectually disposes of all question as to the permanency and stability of the structure, and although only partially completed, this example is a most conclusive demonstration of the correctness of the principle.

It is greatly to be desired that such a construction be given opportunity to show its action at the mouth of the Mississippi, and it is to be trusted that the plans of Professor Haupt will be given the consideration which their merits demand.

Coast Communication With the Great Lakes.

THE Erie Canal was one of the principal agents in establishing the commercial supremacy of New York—both state and city—and during the first half century of its existence it served well the purpose for which it was built. The freight carried on it annually increased from 667,000 tons in 1837 to a maximum of 4,600,000 in 1880, but since then the traffic has fallen to 2,400,000 tons in 1899.

Whatever may be the reasons for this decline, it is certain that the Erie Canal, in its present condition, fails to meet the demands of modern commerce, and if it is not soon radically improved and brought up to date, it will fall into almost complete disuse.

The enormous development of railways in the United States has, of late years, absorbed almost all the attention of those interested in transportation, and when canals have been considered at all, they have been looked upon as relics of a by-gone age. It may be accepted as a fact that the old-

fashioned canals, with a depth of water of only 4 or 6 feet, and carrying boats with a capacity of a couple of hundred tons, have outlived their usefulness, but the country is beginning to realize that these are not the only canals, and that in other parts of the world the development of waterways, fully up to the modern requirements, is being earnestly advocated and has already made considerable progress.

Even in the United States the great traffic on the Sault Ste. Marie canal and other connecting waterways of the Great Lakes has shown the enormous possibilities of through water transit between the Great Lakes and the coast, and lends particular interest to various projects for securing such means of communication.

Last year a New York Canal Commission was appointed by Governor Roosevelt to consider the whole question of the Erie Canal, as well as the more general one of a waterway between Buffalo and the Hudson River; and in its report, issued several months ago, this commission advocates the construction of a barge canal between Buffalo and Albany, following in general the line of the Erie Canal, and having a depth of 12 feet, with a cross-section of 1,200 square feet, which would enable it to carry 1,000-ton barges. The length of this canal would be 341 miles, and its estimated cost about $59,000,000.

A United States Commission has also issued a report on ship canals 21 feet deep and 30 feet deep, between Buffalo and New York, and a comparison of these various reports gives us some data for determining the relative merits of the different projects. The whole subject is interestingly discussed in two papers in a recent number of the *Proceedings of the American Society of Civil Engineers,* one by Mr. Joseph Mayer and the other by Mr. George Y. Wisner.

The United States Commission proposes the cutting of a canal around Niagara Falls from the upper to the lower reaches of the Niagara River, thus connecting Lake Erie with Lake Ontario. The waterway would leave Lake Ontario again at Oswego and proceed by Oneida Lake and the Mohawk River to the Hudson. An alternative route proposed is from the St. Lawrence River to Lake Champlain, and thence to the Hudson.

The Oswego-Mohawk route has two variants, a high-level and a low-level plan, which differ chiefly in the amount of lockage required, the other features being very similar. The length of standard canal on all three routes is almost the same, namely, 102 miles, but the total distance from Buffalo to New York by the Champlain route is 685 miles, while by the Oswego-Mohawk it is only 477 miles. The length of canalized river by the Champlain route is 134 miles, by the Oswego-Mohawk, 96 miles, and distances on open lake and river are, respectively, 449 and 279 miles.

The proposed cross-section of the 21-foot waterway is 5,500 square feet.

The estimated costs of the waterways proposed by the United States Commission are as follows:

	30-Ft. Channel.	21-Ft. Channel.
Lake Erie to Lake Ontario	$73,000,000	$42,000,000
Lake Ontario to New York—Oswego-Mohawk Route (High Level Plan)....	206,000,000	155,000,000
Oswego-Mohawk Route (Low Level Plan)....	210,000,000	157,000,000
St. Lawrence-Champlain Route	213,000,000	141,000,000

The total cost of a 21-foot channel from Lake Erie to New York varies from $183,000,000 to $199,000,000, as compared with $59,000,000 for the proposed barge canal of the New York Commission.

The great advantage to be derived from a ship canal is the through carriage of freight from any port on the Great Lakes to New York, the coast harbors of the United States and even to foreign countries. This great controlling advantage would be entirely missed by a barge canal, which would require the transshipment of freight at Buffalo from lake steamer to barge, and again at New York from barge to ocean steamer if the destination lay beyond that city. The barge canal would be merely an enlarged Erie Canal, with many of the latter's inherent disadvantages, and would be, at the best, but a temporary expedient.

Concerning the relative advantage of a 21-foot and a 30-foot channel, it is held that

the size of vessel which can navigate the former answers all the requirements for safe and economic transport on the Great Lakes; and as the bulk of the traffic through the canal would go no further than New York or other places on the Atlantic seaboard, it would hardly pay to excavate a channel deep enough to accommodate the largest class of ocean steamships.

All things considered, the conclusion is reached that the 21-foot waterway is adequate and is best.

The Massena Power Plant.

THE visit of a number of engineers to the works of the St. Lawrence power plant at Massena, gives opportunity to review the progress of that important work, and from an account in a recent issue of the *Engineering Record* some extracts are made.

The hydraulic head is obtained by cutting a canal across from the St. Lawrence to the Grasse river, a stream which runs nearly parallel to the former, and further down discharges into it. The difference in level at the point where the canal is cut gives a power head of about 40 feet, this practically being the fall of the Long Sault Rapids. The tremendous volume of water available renders this an opportunity for the development of a great amount of power, and plans have been made for the early utilization of 90,000 horse power.

The power is to be generated by fifteen sets of turbines, each set consisting of six wheels placed upon a horizontal shaft, at the extremity of which is placed an electric generator. Each set is rated at 6,000 horse power, the generators being of 5,000 horse power capacity. This arrangement differs materially from that at Niagara, the difference being that properly due to the difference in conditions. At Niagara the head is great and the volume available is limited, while at Massena there is only about one-third the head, and much greater volume of water.

The canal by which the water is to be brought from the St. Lawrence is to be 16,200 feet long, and of the total 5,922,000 yards of excavation needed for the first installation of the power station, 4,279,000 yards have been removed. It is now estimated that the plant will be ready for operation by July of 1901, and the turbine plant for the preliminary installation of 37,500 horse power is now on the ground, ready for installation.

The details of the generators, which have been designed for the plant by the Westinghouse Company, are fully given in the article referred to, and it is expected that a high degree of efficiency will be attained. The control of the output of electricity is especially interesting. One man, by manipulating a series of electric buttons arranged on a small stand, will be able to control instantaneously a power as great as that of three of the largest ocean steamships. Running the length of the power house will be raised a platform, in the middle of which will be built a central controlling stand, made desk fashion, and semi-circular in shape, so that an engineer stationed at its centre will have within reach the controlling apparatus of the entire station.

Mathematics for Engineers.

THE vexed question about the value of a full mathematical training for engineers has been discussed again of late in the columns of *Engineering News*, and some of the points brought out are of importance in connection with engineering education.

As a matter of fact the trouble is not so much with the mathematics as with the manner of teaching. There is no doubt that in many text books the mathematical formulæ and demonstrations are purposely used to display the author's erudition rather than to furnish the pupil with a mastery of one of the most powerful tools ever devised to aid the mind in its conquest of matter. It should be understood that a knowledge of mathematics is a means to an end, a weapon which, to be effectively used, must be fully mastered, and that rote methods and memorized recitations are of about the same value as they would be in teaching the pupil to swim or to ride a bicycle.

The real object of engineering education is to enable the pupil to do things, and in this preparation for his life work he should consider his mathematics as he regards his other professional instruments. Small value will it be to him to be able to rectify well-known curves, by the use of the calculus, for example, if he does not know what he wants the curve for, or cannot apply the knowledge after he has got it.

In many instances the man who is teaching the mathematics is not himself a working engineer, and with all his knowledge of text book methods and reasoning, would be as badly stumped as his pupil if called upon to solve the same problems. It is not unlike the study of a modern language. No matter how well the student may have worked over his grammar and dictionary, he finds his most severe examiner in the first native child with whom he tries to talk, if he has not been given opportunity to absorb by ear the sounds he must understand and make understood.

There is great need for some entirely new mathematical text books, written by engineers for engineering students, and dealing with the actual problems which these same engineers have met and solved. An important qualification for teaching mathematics in a technical school should be a number of years of actual hard practical experience in the application of mathematics to real constructive work. It is not manufactured problems that the professor should set before his pupils; he should not have the convenient privilege of neglecting certain inconvenient elements in the problem in order to make it fit the old-time book methods. Working conditions have an inconvenient habit of appearing in the final result even when they have been neglected in the computation, and in many instances a reputation has been made or marred by the manner in which a problem has been sized up before the computation was begun.

The science of mathematics is all right, and the engineer who really possesses a thorough working knowledge of that science has a great advantage over his less fortunate brother, all other things being equal. The real trouble is that when a man has the knowledge and ability to teach mathematics to engineering students as it ought to be taught, he is able to do so much better for himself outside of the technical school that the professorial chair has no attractions for him.

American Railway Statistics.

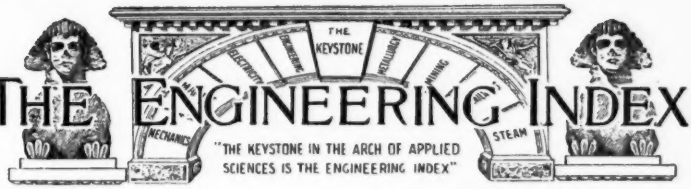
THE appearance of Poor's Manual of Railways and the report of the Statistical Bureau of the Interstate Commerce Commission form the occasion of a review of American railway statistics in a recent issue of *Engineering News*, from which some interesting notes may be made.

Upon the interesting question of total railway mileage, the reports practically agree in making it about 190,000 miles. Great precision cannot be expected in such an indeterminate quantity, since the inclusion or exclusion of electric lines operated by main-line railways, and the question of allowance for yard track and sidings makes an important difference.

There are about 37,000 locomotives in use, and a total of 1,295,000 freight cars, of which 730,000 are fitted with air brakes, and a little more than 1,000,000 with automatic couplers. These are the figures for about a year earlier than the final time, August 1, 1900, allowed by the Interstate Commerce Commission for the enforcement of the law, and as the law does not require all the cars to be equipped with air brakes, but only enough in each train to enable it to be controlled from the engine, there has been ample time to enable the equipment to be completed.

"The movement toward heavier train loads is well shown in the statistics, the average freight-train load in 1899 being 243.52 tons. This is a jump of 17 tons above 1898, and of nearly 40 tons from the figures of 1897, while if we go back to 1890 we find the average freight-train load to have been but 175 tons. Thus the average paying load of the American freight train has increased nearly 40 per cent. in the past decade—a fact worth remembering.

"It is this heavier train loading, more than anything else, which has rendered possible the marvelous drop in rates, which have fallen from an average of 0.941 cents per ton-mile in 1890, to 0.724 cents in 1899. It is worth noting that with the exception of 1892 the drop in rates has been continuous. The average freight train earnings per mile run have remained nearly stationary, but have on the whole slightly increased, the heavier loading a little more than offsetting the lower receipts per ton-mile. Passenger rates have fallen as well as freight rates, though not so rapidly; reaching last year an average per mile of 1.925 cents. Only in 1898 and 1894 has an average rate below 2 cents ever before been reached."



The object of this Index is to supply all persons interested in engineering and industrial pursuits with, first, an expert descriptive summary clearly indicating the character and purpose of the leading articles published currently in the established technical journals of the United States, Great Britain, and the Continent—in all languages; and, secondly, an inexpensive means of readily obtaining any portions of this literature that may be desired by our readers.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

American Architect. *w.* Boston, U. S. A.
American Electrician. *m.* New York.
Am. Engineer and Railroad Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Geologist. *m.* Minneapolis, U. S. A.
American Jl. of Science. *m.* New Haven, U. S. A.
American Machinist. *w.* New York.
Am. Manufacturer and Iron World. w. Pittsburg, U. S. A.
American Shipbuilder. *w.* New York.
Annales des Pontes et Chaussées. *m.* Paris.
Architect. *w.* London.
Architectural Record. *qr.* New York.
Architectural Review. *s-q.* Boston, U. S. A.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Sydney.
Automobile Magazine. *m.* New York.
Automotor & Horseless Vehicle Jl. *m.* London.
Brick Builder. *m.* Boston, U. S. A.
British Architect. *w.* London.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bulletin Am. Iron and Steel Asso. *w.* Philadelphia, U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bulletin of the Univ. of Wisconsin, Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
California Architect. *m.* San Francisco, U. S. A.
Canadian Architect. *m.* Toronto.

Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Montreal.
Canadian Mining Review. *m.* Ottawa.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Contemporary Review. *m.* London.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Eclairage Electrique. *w.* Paris.
Electrical Engineer. *w.* London.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electrical World and Engineer. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Elektrizität. *b-w.* Leipzig.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Cleveland, U. S. A.
Engineers' Gazette. *m.* London.
Engineering. *w.* London.
Engineering and Mining Journal. *w.* New York.
Engineering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penn'a. *m.* Pittsburg, U. S. A.
Fire and Water. *w.* New York.
Foundry. *m.* Detroit.
Gas Engineers' Mag. *m.* Birmingham.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e d. Str. Ferr. *w.* Rome.
Glaser's Ann. f. Gewerbe & Bauwesen. *s-m.* Berlin.
Horseless Age. *m.* New York.
Ice and Refrigeration. *m.* New York.
Indian and Eastern Engineer. *m.* Calcutta.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron & Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland.
Journal Assn. Eng. Societies. *m.* Philadelphia, U. S. A.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Journal of Sanitary Institute. *qr.* London.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery. *b-m.* Fort Monroe, U. S. A.
Journal Western Soc. of Eng. *b-m.* Chicago,
Journal of Worcester Poly. Inst., Worcester, Mass.
L'Energie Electrique. *w.* Paris.
Locomotive. *m.* Hartford, U. S. A.
Locomotive Engineering. *m.* New York.
Machinery. *m.* London.
Machinery. *m.* New York.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Metal Worker. *w.* New York.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. *w.* San Francisco, U. S. A.
Mining Reporter. *w.* Denver, U. S. A.
Mitt. aus d Kgl. Tech. Versuchsanst. Berlin.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Modern Machinery. *m.* Chicago.
Moniteur des Architects. *m.* Paris.
Moniteur Industriel. *w.* Paris.
Municipal Engineering. *m.* Indianapolis, U. S. A.
National Builder. *m.* Chicago.
Nature. *w.* London.
Nature. *w.* Paris.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Nineteenth Century. *m.* London.
North American Review. *m.* New York.
Oest. Monatsschr. f. d. Oeff. Baudienst. *m.* Vienna.
Oest. Zeitschr. f. Berg- & Hüttenwesen. *w.* Vienna.
Ores and Metals. *w.* Denver, U. S. A.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Proceedings Engineers' Club. *qr.* Philadelphia, U. S. A.
Proceedings St. Louis R'way Club, *m.* St. Louis, U. S. A.
Progressive Age. *s-m.* New York.
Railroad Car Journal. *m.* New York.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago.
Review of Reviews. *m.* London & New York.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Marittima. *m.* Rome.
Sanitary Plumber. *s-m.* New York.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Stahl und Eisen. *s-m.* Düsseldorf.
Stevens' Institute Indicator. *qr.* Hoboken, U. S. A.
Stone. *m.* New York.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago.
Telephone Magazine. *m.* Chicago.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. of Civil Eng. *m.* New York.
Trans. Am. Soc. of Heat & Ven. Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
Western Electrician *w.* Chicago.
Wiener Bauindustrie Zeitung. *w.* Vienna.
Yacht. *w.* Paris.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a. S.
Zeitschrift für Elektrotechnik. *s-m.* Halle a. S.

ARCHITECTURAL ENGINEERING

CONSTRUCTION.

Chimneys.

Chimney Construction. E. J. Philip. Read before the Can. Assn. of Sta. Engrs. Considers the method of designing chimneys for a given purpose. 1100 w. Can Engr—Oct., 1900. No. 37148.

The Design of High Chimneys and Other Similar Structures. Editorial discussion of the stability, rather than the draft, of chimneys. 900 w. Eng Rec—Sept. 29, 1900. No. 36864.

Defects.

Some Defects in Buildings. William O. Ludlow. Discusses some of the defects appearing in buildings and their causes, with suggestions as to what not to do. 1400 w. Stevens Ind—Oct., 1900. No. 37401 D.

Foundations.

Foundations of Buildings. S. Anglin. Read before the Manchester Soc. of Archts. Discusses what constitutes a good foundation and the working loads different foundations are capable of sustaining. 4500 w. Stone—Sept., 1900. No. 36970 C.

Testing Foundations Under Difficult Conditions. Describes methods of making borings in basements with low head room, and in regular use by occupants. 1300 w. Eng Rec—Oct. 20, 1900. No. 37199.

High Buildings.

Height of Buildings. Continuation of an informal discussion on this subject. 7000 w. Pro Am Soc of Civ Engs—Oct., 1900. No. 37259 E.

The Highest Building in the World. Illustration and interesting information in regard to a fine office building about to be erected at the southeast corner of 33d st. and Broadway, New York City. 1000 w. Fire & Water—Oct. 13, 1900. No. 37158.

Hospital.

A Children's Summer Hospital. Illustrated description of the arrangement of the Lewis Memorial Cottage, New Dorp, N. Y., for the treatment of children during the summer months. 800 w. Eng Rec—Oct. 6, 1900. No. 37041.

Library.

The Oakland Public Library. Illustrated description of Carnegie library, with shelf room for 30,000 volumes. 600 w. Eng Rec—Oct. 13, 1900. No. 37146.

Sanitary Building.

House Building from a Surgeon's Standpoint. H. C. Wyman. Describes some things in badly constructed houses that interfere with the health of the inmates. 3700 w. Dom Engng—Oct. 15, 1900. No. 37161 C.

Steel Framing.

The New York Clearing House Dome. Illustrated description of special framing for a heavy hemispherical dome 60½ ft. in diameter. 600 w. Eng Rec—Sept. 29, 1900. No. 36868.

Theatres.

Theatre Construction. Clarence Backhouse. Read before the Insurance Inst., Sydney, Australia. Hints on the planning and construction. 6000 w. Aust Min Stand—Aug. 30, 1900. No. 37073 B.

The Mechanics of Stage Effects (Ueber Bühnentechnik). F. Brandt. A general review of the machinery for producing stage effects, from early times to the present. Two articles, 4000 w. Glaser's Annalen—Oct. 1, 15, 1900. No. 37338 each D.

HEATING AND VENTILATION.

Bank.

Ventilation and Heating of the Detroit State Savings Bank. Illustrated description of special plant for heating by direct radiation and ventilation by the downward system of air distribution. Both the plenum and exhaust systems of ventilation are used. 1600 w. Eng Rec—Sept. 29, 1900. No. 36871.

Building Equipment.

Light, Heat and Power in Buildings. Alton D. Adams. Presents the advantages of a combined plant. 2800 w. Archts' & Builds' Mag—Oct., 1900. Serial. 1st part. No. 36987.

The Mechanical Plant of a Large Apartment House. Illustrated description of the heating, ventilating, lighting, refrigerating and elevator plant in a 13-story, 150 x 75 ft. apartment house in New York. 3500 w. Eng Rec—Oct. 27, 1900. No. 37294.

Fan System.

Heating and Ventilating. Illustrated description of a fan system as applied in the Jackson school, in St. Louis. 1600 w. Dom Engng—Oct. 15, 1900. No. 37-165 C.

Greenhouses.

Heating and Ventilation with Regard

We supply copies of these articles. See introductory.

to Greenhouses. Robert W. King. Read before the Can. Hort. Assn., at Montreal. Conclusions from experience as to the best means of securing economic and efficient heating. 6300 w. Can Archt—Sept., 1900. No. 36894 C.

Hot Water.

A Large Residence Heating Apparatus. Illustrated description of the plant for heating a 62-room house by hot water; the front portion chiefly by indirect radiation and the back portion by direct radiation. 1300 w. Eng Rec—Oct. 13, 1900. No. 37145.

School Building.

Heating the West Hoboken School Building. Illustrated detailed description. 2000 w. Met Work—Oct. 13, 1900. No. 37078.

Steam Heating.

Tube Diameters in Low Pressure Steam Heating (Die Rohrweiten der Niederdruck Dampfheizung). H. Krug. Showing a method of proportioning the tube diameters with regard to the fall of pressure in a low-pressure system. 6000 w. 1 plate. Gesundheits Ingenieur—Sept. 30, 1900. No. 37334 B.

Waste Heat.

Utilizing Waste Heat from Electric Light Plants for House Heating. Considers in detail the requirements of the system. 5800 w. Dom Engng—Sept. 15, 1900. No. 36891 C.

PLUMBING AND GAS FITTING.

Drain Testing.

Drain Testing by the Application of Water. J. R. Anderson. Discusses arguments for and against this method of testing, but considers it the only reliable test to apply to house drains under ground. 2100 w. Dom Engng—Oct. 15, 1900. No. 37162 C.

Factory Plumbing.

Plumbing in a Detached Manufacturing Plant. Illustrated description of special work in the Weston Electrical Instrument Works, and of a special sewage disposal system. 2100 w. Eng Rec—Oct. 6, 1900. No. 37043.

Progress.

How Plumbers Used to Work in Chicago. David Whiteford. Shows changes in methods caused by improved inventions and a better understanding of sanitary laws. 5600 w. Dom Engng—Oct. 15, 1900. No. 37164 C.

The Progress and Advancement of Plumbing. Reviews some of the improvements in the materials used and manner of executing work. 2300 w. Dom Engng—Oct. 15, 1900. No. 37163 C.

Special Work.

Plumbing in the Cornell Medical College. Illustrates and describes special work for a medical laboratory. 1800 w. Eng Rec—Oct. 20, 1900. No. 37201.

Water Supply.

A Simple Water Supply System in a Tall Building. A description of the water plumbing in a 17-story New York building without roof tanks, the water being pumped into a compression tank in the basement, where 120-lbs. pressure is maintained by compressed air. 700 w. Eng Rec—Oct. 6, 1900. No. 37042.

MISCELLANY.

Acoustics.

Architectural Acoustics: Hall of Representatives, U. S. Capitol, 1853. Letter from W. R. Hutton, describing investigations by Capt. Meigs and Professors Henry and Bache. 900 w. Eng Rec—Oct. 20, 1900. No. 37203.

The Greek Theatres and Their Lesson in Acoustics. John Lyman Faxon. Part first is a résumé of Greek history and the development of civilization which led to the establishment of the theatre; introductory to the subject. 2000 w. Archts' & Builds' Mag—Oct., 1900. Serial. 1st part. No. 36986.

Stained Glass.

Stained Glass at the Paris Exhibition. Critical review of the exhibits of this product. 1600 w. Builder—Sept. 29, 1900. No. 37017 A.

CIVIL ENGINEERING

BRIDGES.

Arches.

Hinged Pointed Arches (Der Spitzbogenträger mit Seheitelgelenk). Adolf Francke. An elaborate mathematical treatment, with plate showing various examples discussed. 3000 w. 1 plate. Oesterr Monatschr f d Oeffent Baudienst—Oct., 1900. No. 37350 D.

Cantilever.

Reinforcing the Niagara Cantilever. Illustrates and describes the method of reinforcing the Michigan Central Railroad's cantilever by means of a new third truss and strengthening the old trusses to have the same deflection as the new one. Part I. describes the old bridge and the method of reconstructing the towers. 2400

w. Eng Rec—Oct. 13, 1900. Serial. Part I. No. 37139.

Strengthening the Cantilever Bridge at Niagara. Brief illustrated description of very difficult work. 1200 w. Sci Am—Oct. 20, 1900. No. 37171.

Concrete-Steel.

The Modified Design for the Memorial Bridge Over the Potomac River at Washington. An illustrated account of the modified design for the concrete-steel arch bridge between Washington and Arlington to commemorate American patriotism. 600 w. Eng Rec—Oct. 13, 1900. No. 37138.

Erection.

Erecting Three Notable Bridges. Brief description of the Clifton, Atbara, and Delaware River bridge-erection methods. 1400 w. Eng Rec—Oct. 27, 1900. No. 37290.

Pneumatic Field Riveting in Railway Bridge Work. Extracts from a report to the Assn. of Ry. Supts. of Bridges and Buildings, giving a statement of advantages of power riveting on three large railway systems. Also editorial discussion. 2500 w. Eng Rec—Oct. 27, 1900. No. 37291.

Temporary Foot Bridge for Placing the Cables of the New East River Bridge. Illustrated description of a temporary suspension bridge for erecting four cables 18¾ inches in diameter and about 3,000 ft. long from anchorage to anchorage. 1600 w. Eng Rec—Oct. 27, 1900. No. 37289.

The Erection of Bridges and Framed Structures (Montages des Ponts et Charpentes). M. Michel-Schmidt. Especially devoted to the methods of erecting recent bridges in France and structures at the Exposition. 4500 w. 5 plates. Mem Soc Ing Civ de France—Sept., 1900. No. 37342 G.

Girder.

A Seventy-one Ton Plate Girder. Illustrated description of a heavy 87-ft. girder and method of its shipment. 900 w. Eng Rec—Oct. 6, 1900. No. 37037.

Reinforcing.

Reinforcing the Newburyport Suspension Bridge. Illustrated description of methods adopted in strengthening for street railway traffic a 244-ft. suspension span built in 1810. 1300 w. Eng Rec—Oct. 6, 1900. No. 37033.

Suspension.

A 1030-Foot Suspension Bridge Span. Illustrated description of a bridge for transporting ore at Miampimi, Mexico. 600 w. Eng Rec—Oct. 20, 1900. No. 37195.

Viaduct.

The Reconstruction of the Kinzua Viaduct. Illustrations and brief account of the reconstruction made necessary by the recent great increase in the weight of engines and rolling stock. It is said to be the fourth highest bridge in the world. 1200 w. Sci Am—Oct. 27, 1900. No. 37243.

CONSTRUCTION.

Concrete.

Rules for Heavy Concrete Work. A summary of the regulations for the extensive U. S. concrete work at Duluth and on the upper Mississippi. 3300 w. Eng Rec—Sept. 29, 1900. No. 36870.

Concrete Masonry.

Concrete Masonry on the Janesville & Southeastern. Illustrated description of interesting features of this work. 1700 w. Ry & Engng Rev—Oct. 13, 1900. No. 37155.

Excavation.

The Excavation of a Swamp. Describes methods of excavating muck in a reservoir basin. 700 w. Eng Rec—Oct. 20, 1900. No. 37197.

Excavator.

Bucket Excavator (Excavateur en Fouille). Illustrated description of a powerful bucket excavator made by Smulders for constructing irrigation works in Java. 1000 w. Génie Civil—Oct. 6, 1900. No. 37308 D.

Foundations.

See Architectural Engineering.

Framed Structures.

Secondary Stresses in Framed Structures. Thomas A. Clark. Formulas and principles from the writings of H. Mandula, of München. 1600 w. Engs' Year Bk., 1900—Univ of Minn. No. 36966 E.

Girders.

The Strength of I-Beam Girders with Reinforcing Plates. C. F. Blake. Describes a method of calculating the size. 400 w. Am Mach—Oct. 4. 1900. No. 36998.

Reinforced Concrete.

The Use of Expanded Metal in Concrete. A. T. Walmisley. Read before the Brit. Assn., at Bradford. Information concerning the use of this material, particulars of tests, etc. 5200 w. Builder—Sept. 15, 1900. No. 36936 A.

Roads.

Engineering Work in Santiago and Puerto Principe. Illustrated description, mainly of work on mountain highways. 3000 w. Eng Rec—Oct. 6, 1900. No. 37035.

Road Construction and System of Control. A. W. Campbell. Read before the Canadian Soc. of Civ. Engs. Discusses what constitutes a good road, and gives the progress in this direction, as shown in various countries. 5400 w. Adv.

Proof—Can Soc of Civ Engs—Oct. 25, 1900. No. 37281 D.

Road Maintenance in Kent, England. Extracts from a paper by F. W. Ruck, on the methods of maintaining 745 miles of main road in a county where the traffic is very heavy. 2000 w. Eng Rec—Oct. 13, 1900. No. 37142.

Stone Road Building on the Jersey Coast. C. E. McDowell. An illustrated account of good road building. 1600 w. Stone—Sept., 1900. No. 36969 C.

The Maintenance and Construction of Main Roads in England and Wales. Abstract of an article by W. Rees Jeffreys in the *C. T. C. Gazette*. Considers legislative changes needed. 1500 w. Auto Jour—Oct., 1900. No. 37240 A.

Swelling Earth.

Swelling Earth. Letter from Frank Olmsted, describing difficulties experienced from swelling earth during construction of street tunnel in Los Angeles. 700 w. Eng Rec—Oct. 6, 1900. No. 37044.

Tunnels.

Survey and Construction of the Cascade Tunnel by the Great Northern Railway Through the Cascade Range, State of Washington. M. E. Reed. Illustrated account of a tunnel being constructed by the most improved methods. 2500 w. Engs' Year Bk., 1900—Univ of Minn. No. 36964 E.

The Tunnel from the Gardanne Mines to the Sea (La Galerie des Mines de Gardanne à la Mer). A description of the work now in progress to enable the lignite mines of Gardanne to be connected with the Mediterranean, near Marseilles. 3000 w. Revue Technique—Sept. 25, 1900. No. 37313 D.

HYDRAULIC AND MARINE.

Aqueduct.

The Construction of the Elan Aqueduct, Birmingham, England. Abstract of a paper by H. Lapworth, printed by Inst. C. E., describing the work on 12½ miles of aqueduct, involving special methods of trenching, tunneling and pipe-laying. 3900 w. Eng Rec—Sept. 29, 1900. No. 36866.

The Conveying of Water and Power from Ferrari-Galliera to Genoa (Wasserleitungs-und Kraftanlagen Ferrari-Galliera zu Genua). P. Kresnik. An account of the plan to bring the water from lakes Bigio and Lungo to Genoa, with details of dam and aqueduct. 4000 w. Zeitschr d Oesterr Ing u Arch Ver—Oct. 12, 1900. No. 37321 B.

Canal Locks.

New System of Closing Canal Locks (Nouveau Système de Fermeture des Ecluses). M. Mazoyer. An illustrated account of the new locks on the canal from Roaune to Digoin, with especial reference to the lock-gates of unusual depth. 2500 w. 1 plate. Annales des Ponts et Chaussées—2 Trimestre, 1900. No. 37-325 E + F.

Canals.

Canals Between the Lakes and New York. Joseph Mayer. Examines arguments for and against the construction of this waterway, showing why private capital cannot safely undertake the construction. 7000 w. Pro Am Soc of Civ Engs—Oct., 1900. No. 37257 E.

The Carillon Canal, Dam and Slide. Ernest Marceau. A short history of earlier work toward improving the navigation of the Ottawa River, with a description of the works named. 4 plates. 7000 w. Can Soc of Civ Engs (Adv. Proof)—Oct. 11, 1900. No. 37133 D.

The Elbe-Trave Canal (Der Elbe-Trave-Canal). J. Riedel. With map and profile, also details of locks. 1800 w. Zeitschr d Oesterr Ing u Arch Ver—Sept. 28, 1900. No. 37319 B.

The Elbe-Trave Canal (Le Canal de l'Elbe à la Trave). G. Henry. An illustrated description, with especial reference to the Hotopp pneumatic locks. 3000 w. 1 plate. Génie Civil—Oct. 13, 1900. No. 37310 D.

The Economic Dimensions for a Waterway from the Great Lakes to the Atlantic. George Y. Wisner. Discusses the economic depth for canals of large traffic, and gives conclusions drawn. Considers the benefits derived from a 21-ft. waterway nearly as great as could be expected with greater depths. 5400 w. Pro Am Soc of Civ Engs—Oct., 1900. No. 37258 E.

Dredges.

Bucket and Suction Harbour Dredge (Drague Marine à Godets, à Succion et à Refoulement). Illustrated description of powerful new dredge, built by Smulders for the harbour of Port Arthur. 1500 w. Génie Civil—Sept. 15, 1900. No. 37-304 D.

Mammoth Dredging Steamer Launched. Describes the launching from the shipyard of the Maryland Steel Co., of the "Thomas," the first of two built to deepen New York harbor. 2700 w. Naut Gaz—Oct. 4, 1900. No. 37002.

The Sea-Going Hydraulic Dredge "Benyaurd." Description of dredge for Southwest Pass of Mississippi River; the dredging machinery has an hourly capacity of 2,000 yards of sand from a depth of 30 ft. 1000 w. Eng Rec—Oct. 6, 1900. No. 37036.

Dry Dock.

Reconstruction in Concrete of Dry Dock No. 2, New York Navy Yard. Brief illustrated account of these repairs.

1500 w. Sci Am—Oct. 20, 1900. No. 37170.

Filtration.

Economical Dimensions of Rectangular Filter Beds. John H. Gregory. Formulas and diagrams of value in making arrangements of filters. 500 w. Eng News—Oct. 11, 1900. No. 37107.

Filtration of Water for Public Use. Continued informal discussion. 3000 w. Pro Am Soc of Civ Engs—Oct., 1900. No. 37260 E.

Surface Water Filters, Marlborough, Mass. Describes filters for the run-off of a well-populated area of 1.8 sq. miles, draining into a large reservoir. Also editorial on the purification of storm water. 1500 w. Eng Rec—Oct. 6, 1900. No. 37040.

Ground Water.

Movements of Ground Water. Benjamin Smith Lyman. Reviews the reports of F. H. King and C. S. Slichter, as given in Part II. of the nineteenth annual report of the U. S. Geol. Survey. 6000 w. Jour Fr Inst—Oct., 1900. No. 36994 D.

Irrigation.

Irrigation in India. F. C. Cotton. The object of the paper is to show how the nation may be rescued from famines and enriched by the water of its great rivers, and the prosperity that will follow. 6300 w. Jour Soc of Arts—Oct. 12, 1900. No. 37204 A.

Lighthouses.

The Lighthouse and Signal Devices of Sautter, Harlé & Co. (Phares et Signaux Sonores Sautter, Harlé et Cie). With illustrations of the workshops and detailed descriptions of the lights and sound signals constructed by this famous French establishment. 2500 w. Revue Technique—Sept. 25, 1900. No. 37312 D.

Lighthouse at Jenningtree Point. Drawing and brief description of a steel-frame lighthouse. 500 w. Engr, Lond—Sept. 21, 1900. No. 36957 A.

Measurement.

Water Measurement in Colorado. Illustrated explanation of methods used in irrigation districts. 1000 w. Fire & Water—Sept. 29, 1900. No. 36910.

Mississippi.

The Projected Improvement of the Southwest Pass. William Starling. Describes the present condition of the pass and gives a full detailed discussion of the project. 14500 w. Eng News—Oct. 4, 1900. No. 37003.

Nicaragua Canal.

Test Borings for the Isthmian Canal Commission. Describes methods of sinking bore-holes through rock and earth on the projected line of the Nicaragua Canal. 1700 w. Eng Rec—Sept. 29, 1900. No. 36867.

Reservoirs.

A Small Concrete and Expanded Metal Reservoir. Illustrated description of a covered circular tank built without centers and provided with expanded metal reinforcement of top, bottom and sides. 1100 w. Eng Rec—Oct. 20, 1900. No. 37196.

Asphalt and Brick Reservoir Linings. Illustrated description of method of lining reservoirs with concrete base, asphalt and burlap water-proofing courses and brick paving. 600 w. Eng Rec—Oct. 6, 1900. No. 37034.

Masonry for Water-Works Plants. Charles A. Hague. On the care needed in building a watertight wall, and the faulty methods used. 2200 w. Fire & Water—Sept. 29, 1900. No. 36909.

Water Analysis.

Standard Methods of Water and Sewage Analysis. A criticism of the divergent methods of analysis and in stating results, which diminish the value of such work to engineers. 1300 w. Eng Rec—Oct. 13, 1900. No. 37135.

Standard Methods of Water Analysis. The recommendations of a special committee of analysts appointed by the American Public Health Assn. 5800 w. Eng Rec—Oct. 27, 1900. No. 37293.

Water Pollution.

Frequent Biological Examination of the Water Supply a Necessity. Showing that the presence of the colon bacillus is frequently discovered and is a sure indication of sewage pollution. 1800 w. Fire & Water—Sept. 22, 1900. No. 36885.

Water Purification.

Rendering the Water of the Seine Wholesome. From *La Nature*. Historical review with illustrated description. 3000 w. Sci Am Sup—Oct. 13, 1900. No. 37072.

Water Rights.

Interstate Rights to Water. A decision by a U. S. District Court, awarding damages to riparian owners of Connecticut against New York City for the diversion of water. 1000 w. Eng Rec—Oct. 13, 1900. No. 37137.

Water Supplies.

Improvement of Water Supplies. G. Bouscaren. Read at Milwaukee meeting of the Am. Soc. of Munic. Imp. On the essential requisites in water for domestic use, and the systems of purification applied. 1400 w. Munic Engng—Oct., 1900. No. 36973 C.

The Newburyport Water-Works Litigation. Review of a decision by a U. S. district court, holding that in the case of a non-exclusive franchise for public

service, a legislative act indirectly forcing an existing company to sell its plant to a city is not a taking without due compensation, against the constitution of the United States. 2300 w. Eng Rec—Oct. 20, 1900. No. 37194.

The Water Supply for the Suburbs of Paris (Die Wasserleitung für die Umgebung von Paris). Thomas Hofer. With plan of the environs of Paris, and details of apparatus for water purification by metallic iron. 4000 w. 1 plate. Oesterr Monatschr f d Oeffent Baudienst—Oct., 1900. No. 37349 B.

Water Works.

Newark Owns Its Water Works. Illustrated description of a nine and a half million dollar plant. 110 w. Fire & Water—Oct. 20, 1900. No. 37229.

The Chestnut Hill Pumping Stations of the Metropolitan Water-Works, Boston. Alfred D. Flinn. The first article illustrates and describes a high-service station and gives a report of a pumping engine test, in which a duty of 157,000,000 ft.-lbs. per million B. T. U. was furnished. 4000 w. Eng Rec—Oct. 18, 1900. Serial. 1st part. No. 37141.

The New England Water-Works Association. Report of convention, giving abstracts of papers by L. P. Kinnicutt on bacterial sewage treatment in England to prevent pollution of rivers, and of M. Knowles on the efficiency of sand and mechanical filters at Pittsburg, with comparative tables. 4000 w. Eng Rec—Sept. 29, 1900. No. 36872.

The New Pumping Station and Water Tower in Vienna. Illustrated description from the *Zeitschrift d. Oest. Ing. u. Arch. Ver.* of an elaborate water tower with both Intze and annular tanks, and small pumping engines with mechanically controlled suction valves; the result of tests of the engines is also given. 1500 w. Eng Rec—Oct. 6, 1900. No. 37038.

The Orange Water-Works Extension. Illustrated description of a new plant using an old abandoned reservoir at higher elevation to furnish water for driving pumps for new supply. 2300 w. Eng Rec—Oct. 27, 1900. No. 37292.

MATERIALS.

Cement Tests.

Accelerated Tests for Cement. A letter on the manner of conducting the Michaelis test, with editorial on the reliability of accelerated tests in general. 1400 w. Eng Rec—Oct. 13, 1900. No. 37136.

Cement.

Weights of Portland Cement and Capacity of Cement Barrels. Sanford E. Thompson. Information compiled from tests made by the Boston Transit Commission. 500 w. Eng News—Oct. 4, 1900. No. 37004.

Concrete.

A Symposium on Concrete and Its Uses. Abstract of information compiled by W. A. Rogers from reports of representatives of over 85,000 miles of railways. 2500 w. Eng Rec—Oct. 20, 1900. No. 37200.

Models.

Models and Model Loading (Modell und Modellbelastung). G. Griot. A discussion of the relative strength of models and full size structures, with an example of a loaded model roof truss. 1200 w. Schweizerische Bauzeitung—Oct. 13, 1900. No. 37333 B.

Timber Reservation.

A Proposed Method for the Preservation of Timber. Continued discussion of paper by F. A. Kummer. 2500 w. Pro Am Soc of Civ Engs—Oct., 1900. No. 37262 E.

MUNICIPAL.

Garbage.

Garbage Cremation at Bradford, England. Describes methods of disposing of most of the ashes and garbage from a population of 300,000, with results of a 278-hour test of plant. 500 w. Eng Rec—Sept. 29, 1900. No. 36869.

Garbage Disposal Works, Syracuse, N. Y. Illustrated description of works on the improved Holthaus system. 1100 w. Eng News—Oct. 11, 1900. No. 37105.

Pavements.

Bacterial Studies of the Healthfulness of Street Pavements of Lafayette, Ind. Daniel B. Luten and Severance Burrage. An illustrated account of investigations to determine the relative number of bacteria liable to be inhaled by breathing the air over the various pavements. 2500 w. Eng News—Oct. 11, 1900. No. 37104.

Refuse.

The Disposal of House Refuse in Bradford. John McTaggart. Read before the British Assn. Describes the refuse destructors, and methods of utilizing the residuum, giving results of working tests. 4200 w. Engng—Sept. 21, 1900. No. 36949 A.

The Disposal of Towns' Refuse. Ed. C. de Segundo. Reviews Mr. McTaggart's paper, read before the British Assn. 1200 w. Elec Rev, Lond—Sept. 21, 1900. No. 36943 A.

Sewage Purification.

Recent Progress in Sewage Purification in England. Abstract of paper read by Gilbert J. Fowler before the Am. Soc. of Munic. Imp. Gives outline of experiments on biological methods of sewage

treatment and conclusions. 900 w. Munic Engng—Oct., 1900. No. 36974 C.

The Unsuccessful Sewage Purification Plant at Madison, Wis. Extracts from the report of F. E. Turneaure, with explanatory notes. 3300 w. Eng News—Oct. 11, 1900. No. 37108.

Sewerage.

Manhole for Gauging. Illustrated description of a special manhole with triangular weir for catching sewage at Liberty, N. Y. 400 w. Eng Rec—Oct. 20, 1900. No. 37202.

Sanitary Conditions in Hong Kong. Abstract of paper by Robert G. Alford, before the Inst. of Civ. Engs., describing the difficulties of sewerage in a community made up mainly of Chinese. 2500 w. Eng Rec—Oct. 20, 1900. No. 37198.

Sydney and Suburbs Low Level Sewerage. A. E. Cutler. Read before the Engng. Assn. of N. S. W. Describes the work as carried out, and the operation of the mechanism employed. 2500 w. Aust Min Stand—Sept. 20, 1900. Serial. 1st part. No. 37253 B.

The Concord Sewage Pumping and Electric Station. Illustrated description of the construction of the foundations of a sewage well and pumping station under extremely difficult conditions, with notes on the power plant. 3900 w. Eng Rec—Oct. 6, 1900. No. 37039.

The Sewerage Works at Flemington, N. J. Illustrated description of the construction and cost of sewers for a village of 2,200 people, with broad irrigation fields for disposal. 2000 w. Eng Rec—Sept. 29, 1900. No. 36865.

The New Sewer Outfall at Burlington, Ia. Illustrates and describes a structure designed to take the place of an outlet three times destroyed by storms. 1000 w. Munic Engng—Oct., 1900. No. 36975 C.

ELECTRICAL ENGINEERING

COMMUNICATION.

Cables.

An Explanation of a Common Phenomenon Noticed in Cable Work. H. G. Barwell. An explanation of the sharp kicks noticed on the galvanometer while a splice is being made. Ill. 1300 w. Elect'n, Lond—Sept. 21, 1900. No. 36940 A.

Some Interesting Faults Met with in Cable Manufacture. J. Wright. Showing the difficulties with which the manufacturer must contend. 2500 w. Elec Rev, Lond—Oct. 12, 1900. No. 37209 A.

Contacts.

Electrical Contracts. Frank C. Mason. Read at the Pittsburg meeting of the International Assn. of Munic. Elect'ns. Discusses the three classes of contacts, and the things that destroy their efficiency. 1600 w. W Elect'n—Oct. 6, 1900. No. 37059.

Impedance.

A Practical Method of Impedance Testing for Telephone Men. Sewall Cabot. Describes a method of calculating the resistance to alternating currents of circuits containing impedance. 400 w. Elec Wld & Engr—Oct. 20, 1900. No. 37214.

Printing Telegraph.

Improvement in the Efficiency of the Hughes Instrument (Erhöhung der Leistungsfähigkeit des Hughes-Apparates). G. Conradt. Discussing an improved arrangement of keyboard, claimed to possess material advantages. 4000 w. Elektrotech Zeitschr—Sept. 13, 1900. No. 37352 B.

Rapid Telegraphy.

The Pollak and Virag Rapid Telegraph (Der Schnell telegraph von Pollak und Virag). An illustrated description of the latest improvements in the system. A legible script message is transmitted, instead of equivalents of the Morse characters. 2500 w. Elektrotech Zeitschr—Oct. 11, 1900. No. 37360 B.

Telegraphone.

The Poulsen Telegraphone (Le Télégraphone Poulsen). G. Briad. A description of this combination of telephone and phonograph, successfully used for recording telephone messages. 1000 w. Génie Civil—Sept. 29, 1900. No. 37306 D.

Vienna.

The Vienna Telephone Stations (Die Wiener Fernsprechämter). H. Dreisbach. Describing especially the underground conductors, and methods of making connections. Serial, Part I. 4500 w. Elektrotech Zeitschr—Oct. 18, 1900. No. 37364 B.

DISTRIBUTION.

Alternating Currents.

Distribution of Power by Alternate Electric Currents. Concerning alternate-current transformers, explaining the principles and operation. Ill. 4700 w. Col Guard—Sept. 21, 1900. Serial. 1st part. No. 36951 A.

Cables.

The Warming of Electric Conducting Cables (Ueber die Erwarmung Elektrischer Leitungskabel). J. Herzog and C. Feldman. With data of observations

upon a number of cables, and methods of computing safe temperature limits. 7500 w. Elektrotech Zeitschr—Sept. 20, 1900. No. 37353 B.

Condensers.

The Use of Condensers. P. Boucherot. Abstract of a paper before the International Elec. Cong., at Paris. Examines the most important applications, and the reasons against their use. 3000 w. Elect'n, Lond—Oct. 12, 1900. No. 37228 A.

Distribution Systems.

Notes on Systems of Distribution. Ellis H. Crapper. The systems are discussed and the factors to be considered in deciding which to adopt. 1000 w. Elec, Lond—Oct. 19, 1900. Serial. 1st part. No. 37279 A.

Systems and Apparatus for Light and Power Distribution. C. P. Steinmetz. Read at convention of the Assn. of Edison Illuminating Companies. Discusses the nature and behavior of the apparatus used. 2800 w. Elec Wld & Engr—Sept. 29, 1900. Serial. 1st part. No. 36903.

Guard Wires.

Overhead Construction, with Special Reference to Guard Wires. Sydney Woodfield. Discusses the cause of accidents, present practice, and suggests points with regard to their erection. Ill. 2800 w. Elec Rev, Lond—Sept. 21, 1900. No. 36941 A.

Rotary Converters

See Mining and Metallurgy, Mining.

Shielding.

The Shielding Action of Iron Tubes (Ueber die Schirmwirkung von Eisenröhren). C. Feldmann and J. Herzog. A comparison between calculations and observations for tubes of various diameters and thicknesses. 1800 w. Elektrotech Zeitschr—Oct. 18, 1900. No. 37362 B.

Wiring.

Interior Wiring. G. C. Allingham. Discusses the systems used and the safety. 2400 w. Elec Rev, Lond—Sept. 28, 1900. No. 37013 A.

ELECTRO-CHEMISTRY.

Electrolytic Baths.

New Process for the Production of Electrolytic Baths. On advantages of an admixture of glycerine. 1100 w. Sci Am Sup—Oct. 27, 1900. No. 37248.

Ions.

Ions, Atoms and Electrons. Reviews the discussion on "Ions" which took place at the Bradford meeting of the British Assn. 2200 w. Elec Rev, Lond—Oct. 5, 1900. No. 37122 A.

Nomenclature.

Electrochemical Nomenclature (Elektrochemische Bezeichnungen). M. A. Hollard. Giving the electrochemical terms adopted by the recent Congress in Paris. 1000 w. Zeitschr f Elektrochemie —Sept. 20, 1900. No. 37369 G.

Primary Cells.

The Osmotic Pressure Theory of Primary Cells. W. R. Cooper. From a book on "Primary Batteries," soon to be published. Explains the nature of osmotic pressure, and of electrolytic solution pressure and manner of calculating the E. M. F. 2300 w. Elect'n, Lond—Sept. 28, 1900. Serial. 1st part. No. 37127 A.

ELECTRO-PHYSICS.

Core Tests.

Transformer Core Ageing Tests. W. Elwell Goldsborough. A report of experimental investigations. 1800 w. Elec Rev, N. Y.—Oct. 17, 1900. No. 37182.

Electric Waves.

Molecular Changes Produced in Matter by Electric Waves. Reviews the paper by Dr. Jagadis Chunder Bose, read before the Royal Society, with comments. 1500 w. Elec Rev, Lond—Sept. 21, 1900. No. 36942 A.

Insulation.

The Ethics of Insulating Materials. J. Wright. Considers the substances, chiefly india-rubber and gutta-percha, used for the insulation of electric cables and wires. 2000 w. Elec Rev, Lond—Sept. 21, 1900. No. 36944 A.

Interrupters.

Method of Determining the Number of Interruptions in Liquid Interrupters (Methoden zur Bestimmung der Unterbrechungszahlen von Flüssigkeitsunterbrechern). Ernst Ruhmer. The interruptions are recorded upon a revolving disk covered with lycopodium. 2000 w. Elektrotech Zeitschr—Oct. 4, 1900. No. 37357 B.

Magnetism.

The Magnetic Properties of Iron Filings as Affected by Ferro-Manganese. Ernest Wilson. Describes methods of experimenting and results obtained. 1100 w. Elect'n, Lond—Oct. 5, 1900. No. 37130 A.

Resistance.

Experiments on High Electrical Resistance. Ogden N. Rood. Explanation of methods and account of experiments. 4200 w. Am Jour of Sci—Oct., 1900. No. 36961 D.

See Street and Electric Tramways.

The So-called "Skin Effect" or the Increased Resistance of Iron Wires to Alternating Currents. B. Hopps. Results of tests and curves. 400 w. Elect'n, Lond—Oct. 12, 1900. No. 37224 A.

Temperature.

Stability of Temperature in an Electric Conductor. H. E. Wimperis. An account of investigations made by the writer. 1100 w. Elect'n, Lond—Oct. 12, 1900. No. 37226 A.

GENERATING STATIONS.

Accumulator.

The Cadmium Accumulator (Accumulateur au Cadmium). A description of the Commelin and Viau system, with a positive plate of peroxide of lead and a negative of deposited cadmium. Diagrams of the performance are given. 1200 w. L'Electricien—Oct. 13, 1900. No. 37367 B.

Air Gap.

The Apparent Increase in the Air-Gap of Dynamos and Motors Due to Toothed Armatures. C. F. Guilbert. Translated from *L'Industrie Electrique*. Describes method of calculating the apparent increase. 700 w. Elec Rev, N. Y.—Oct. 10, 1900. No. 37150.

Alternators.

Alternating Current Plants (Ueber Wechselstromanlagen). H. S. Myer. A general discussion of the points to be considered in installing an alternating-current plant. 5000 w. Elektrotech Zeitschr—Oct. 18, 1900. No. 37361 B.

Conditions Affecting the Wave Form of Alternators. L. A. Herdt and E. M. Archibald. Paper read before the Can. Elec. Assn. Considers the extent to which the E. M. F. wave of certain machines may change under not unusual commercial conditions. Ill. 800 w. Can Engr—Sept., 1900. No. 36887.

Extending Applications of Alternating Machines. Alton D. Adams. On the rapid rate at which this machinery has grown in favor for both light and power, and its advantages. 2500 w. Sci Am—Oct. 27, 1900. No. 37245.

Buenos Aires.

The Plant of the General Electric Company of Buenos Aires (Das Elektricitäts werk der Compania General de Elektricidad de Buenos Aires). W. Hulke. A very full description, with many illustrations showing the course of erection of the machinery. 4000 w. Elektrotech Zeitschr—Oct. 11, 1900. No. 37358 B.

Dynamos.

A Continuous-Current Dynamo for Widely Varying Voltages, Designed by E. Lanhoffer. Condensed translation from *L'Electricien*. Illustrates and describes the machine and its action, making claims that the editor considers too wide to be substantiated. 3500 w. Elec Engr, Lond—Oct. 12, 1900. No. 37206 A.

Continuous Current Dynamo with Differential Pressures (Dynamo à Courant Continu à Tension Différentielle). A description of the Lanhoffer system, by which a variation in the pressure of the current is obtainable. 3000 w. L'Electricien—Sept. 29, 1900. No. 37366 B.

On the Construction of Dynamo-Electric Machines. Maurice Leblanc. Read before the International Cong., at Paris. Description, with illustrations of construction on lines approved by the writer. 4200 w. Elect'n, Lond—Oct. 12, 1900. No. 37227 A.

The Dynamos of the International Electrical Company (Les Dynamos de la Compagnie Internationale d'Electricité). Paul Saney. Especially describing the 1,000 kilowatt three-phase generator shown at Paris, coupled to a compound steam engine by Van den Kerchove. 1200 w. Revue Technique—Oct. 10, 1900. No. 37315 D.

The Philosophy of Dynamo Design. Considers various points that must be kept in mind by the successful designer of continuous-current machines. 2200 w. Elec Engr, Lond—Oct. 17, 1900. Serial. 1st part. No. 37284 A.

The Tendency of Modern Dynamo Design. William Cramp. Conclusions reached by a study of the exhibits at the Paris Exhibition. Ill. 2000 w. Elec Engr, Lond—Oct. 5, 1900. No. 37124 A.

Generating Set.

Belleville-Breguet Compound Generating Set (Groupe Electrogène Belleville-Breguet). A description of the exhibit at the Paris Exposition, and an analysis of the action of the compound alternator. 3500 w. L'Electricien—Oct. 20, 1900. No. 37368 B.

Generating Set of 1,000 Kilowatts (Groupe Electrogène de 1,000 Kilowatts). Ch. Dantin. Illustrated description of the set consisting of a 1,250 h. p. Delaunay Belleville engine connected to a 1,000 kilowatt three-phase generator, by Breguet, exhibited at Paris. 3000 w. 1 plate. Génie Civil—Sept. 8, 1900. No. 37300 B.

Generators.

The Designing of Large Tramway Generators. Horace F. Parshall. Discusses the subject in relation to efficiency. The losses, dimensions, etc., are also considered. 3500 w. St Ry Jour—Oct. 13, 1900. No. 37081 D.

Geneva.

The Electricity Works of Chèvres (Geneva). An illustrated account of some of the difficulties overcome and successes achieved in this hydraulic undertaking. 2200 w. Elec Rev, Lond—Oct. 12, 1900. Serial. 1st part. No. 37208 A.

Power Factor.

Power Factor as Affecting Operation and Investment, with Special Reference

to Induction Motors and Enclosed Arc Lamps. F. H. Leonard, Jr. Read before the Can. Elec. Assn. Deals with subjects of importance to central station managers. Also discussion. 5700 w. Can Engr—Sept., 1900. No. 36888.

Power Plants.

Barnsley Electricity Supply Works. Historical and descriptive account, with illustrations. 4800 w. Elec Engr, Lond—Sept. 21, 1900. No. 36938 A.

The New Municipal Power Stations in Liverpool. Illustrated description of a plant to meet the rapidly increasing demand for electrical energy for lighting and for tramways. 1900 w. Elect'n, Lond—Oct. 19, 1900. No. 37285 A.

The Electric and Hydraulic Power Plant of the Saint Lawrence Power Company, Massena, N. Y. Charles T. Child. Illustrates and describes the engineering and construction features of this enormous development of hydraulic power for electric transmission and utilization. 2200 w. Elec Rev, N. Y.—Oct. 24, 1900. No. 37298.

Power Station.

See Street and Electric Tramways.

Station Test.

Test of the Lighting and Power Station of Cornell University. M. W. Buchanan and F. J. Folk. Abstract of thesis presented for degree of M. E. Describes the turbines, engines, boilers, and dynamos, and the tests made, with remarks on the plant. 2000 w. Sib Jour of Engng—Oct., 1900. No. 37178 C.

Storage Batteries.

See Street and Electric Tramways.

Transformers.

A New Constant-Potential Continuous Current Transformer. F. W. Davis. Brief illustrated description of a simple method of compensating for the voltage drop in the secondary at full load. 1000 w. Elec Rev, Lond—Oct. 19, 1900. No. 37286 A.

The Latest Development in Transformer Design and Operation. H. C. Wirt. The reasons why old forms have been discarded; the requirements; and illustrated descriptions. Also discussion. 2800 w. Jour of Elec—Aug., 1900. No. 36893.

Wind Power.

Wind Power for Electrical Purposes. Roy E. Thompson. Explains the methods by which wind power may be applied and how they are governed. 1400 w. Engs' Year Bk., 1900—Univ of Minn. No. 36965 E.

HEATING AND WELDING.

Water Heater.

The Ougrimoff Electric Heater (Calorifacteur Electrique, Système Ougrimoff). J. A. Montpéllier. The water is heated by an electric arc enclosed in the center of the containing vessel. 1200 w. L'Electricien—Sept. 22, 1900. No. 37-365 B.

LIGHTING.

Accounting.

A Model System of Book-Keeping for Electric Lighting Companies. John Lyle Clough. Outlines the system used by the Edison Light Co., of Grand Rapids, Mich. 1300 w. Munic Engng—Oct., 1900. No. 36971 C.

Arc Lighting.

Arc Lighting in Power Transmission Service. H. W. Hillman. Discusses the enclosed arc system; the troubles of the past and the remedies; the advantages, etc. Ill. Also discussion. 6500 w. Jour of Elec—Aug., 1900. No. 36892.

Glasgow.

The Electric Lighting of the City of Glasgow. Begins an illustrated description of the Glasgow electricity works at Port Dundas. 2400 w. Elec Engr, Lond—Sept. 21, 1900. Serial. 1st part. No. 36939 A.

Illumination.

The Light Emitted by the Continuous-Current Arc. Mrs. Ayrton. Abstract of a paper read before the International Congress, at Paris. A record of scientific investigation, with editorial comment. 5500 w. Elect'n, Lond—Oct. 12, 1900. Serial. 1st part. No. 37225 A.

Lamp Rating.

Mistakes in the Rating of Incandescent Lamps. Arthur J. Rowland. A discussion of some things regarding the real candle-power and watts per candle power, etc. 2000 w. Jour Fr Inst—Oct., 1900. No. 36992 D.

Lamps.

Development of Electric Lamps. André Blondel. Abstract of a paper read before the Inter. Elec. Cong., at Paris. Reviews the progress and the improvements desirable in arc and incandescent lamps. 3300 w. W Elect'n—Sept. 29, 1900. No. 36921.

Photometry.

Photometry. J. Violle. Abstract of a report to the International Elec. Cong., at Paris. 4800 w. Elect'n, Lond—Sept. 28, 1900. No. 37128 A.

Street Lighting.

A Modern Street Lighting Plant. George A. Damon. Illustrated description of the municipal arc-light plant at Grand Rapids, Mich. 2400 w. Am Elect'n—Oct., 1900. No. 37061.

Statistics on Electric Street Lighting. Report of F. W. Coppelen, based on sta-

tistics published by the U. S. Dept. of Labor. 1000 w. Munic Engng—Oct., 1900. No. 36972 C.

MEASUREMENT.

Alternating Currents.

The Accurate Measurement of Alternating and Multiphase Currents. G. L. Addenbrooke. Abstract of paper read at the International Congress, at Paris. Gives results of experience, describing the method and the design of the apparatus and instruments, and the manner of using them. 3700 w. Elect'n, Lond—Oct. 5, 1900. No. 37131 A.

Cable Resistance.

Measurement of the Resistance of Cables. Arthur C. Heap. Describes the potentiometer, and the method of measuring for the use of manufacturers. Ill. 2000 w. Elec Rev, Lond—Oct. 5, 1900. No. 37121 A.

Drop.

Ohm's Law Applied to the Calculation of Drop in Constant Current Circuits. Albert F. Ganz. Considers a number of numerical problems illustrating the calculation of drop in various forms of lighting circuits. 1800 w. Stevens Ind—Oct., 1900. No. 37402 D.

Electrodynamometer.

Mirror Electrodynamometer for Technical Uses (Elektrodynamometer mit Spiegelablesung für Technische Zwecke). J. Kollert. Fully illustrated description of the dynamometer, with mathematical demonstration of its action. 6000 w. Elektrotech Zeitschr—Sept. 20, 1900. No. 37354 B.

Motor Slip.

A Method for Measuring the Slip of Induction Motors. W. Hand Browne, Jr. Describes a method in which the slip is measured directly, and which has been found entirely satisfactory during a year's use. 1300 w. Elec Wld & Engr—Oct. 13, 1900. No. 37103.

Power Indicator.

Power Factor Indicator. Aug. J. Bowie, Jr. Describes an instrument that will indicate the power factor directly on a scale suitably calibrated. 1500 w. Elec Wld & Engr—Oct. 27, 1900. No. 37268.

Recording Instruments.

Switchboard Improvements. Recording Ammeters, Voltmeters, and Wattmeters. William Baxter, Jr. Illustrates and describes several intsruments. 1700 w. Am Mach—Oct. 4, 1900. No. 36997.

Resistance Bridge.

A Universal Carey-Foster Bridge. Charles V. Drysdale. An illustrated description of the writer's method of using the Carey-Foster bridge in resistance work. 1800 w. Elect'n, Lond—Oct. 5, 1900. No. 37129 A.

Resistances.

Otto Wolf's Standard Resistances in Electrical Measurement. Wallace M. Hill. Description of methods, with illustrations. 3500 w. Stevens Ind—Oct., 1900. No. 37403 D.

Testing.

Dynamo and Motor Testing. John H. Hertner. Points out a number of shop and laboratory tests, showing how they are applied, and gives a few practical methods of discovering and curing dynamo and motor diseases. Ill. 2500 w. Engr, U. S. A.—Oct. 1, 1900. No. 36927.

POWER APPLICATIONS.

Agriculture.

The Application of Electricity to Agriculture. George E. Walsh. Some methods used to stimulate crops and to lessen the cultivation and transportation labor. 1500 w. Elec Rev, N. Y.—Oct. 10, 1900. No. 37151.

Brakes.

Electric Brakes for Alternating Currents (Elektrische Bremsen für Wechselströme). J. Fischer-Hinnen. With especial reference to electrically released mechanical brakes for hoisting machinery. Methods of designing brakes for one, two, and three-phase currents are given. 3500 w. Elektrotech Zeitschr—Sept. 13, 1900. No. 37351 B.

Cranes.

See Mechanical Engineering, Machine Works and Foundries.

Current Consumption.

See Street and Electric Tramways.

Cutting Iron.

Cutting Structural Iron by Means of the Electric Arc. J. R. Cravath. Brief account of manner of doing the work. 600 w. Am Elect'n—Oct., 1900. No. 37063.

Electric Motor.

See Street and Electric Tramways.

Machine Driving.

Motor-driven Lathes. Illustrates and describes different methods in use. 800 w. Elec Rev, Lond—Sept. 28, 1900. No. 37012 A.

Mining Plant.

The Electric Power Plant of the Redjang Lebong Gold Mine, Sumatra (Die Elektrische Kraftübertragungsanlage der Goldgrube Redjang-Lebong, Sumatra). W. Philippi. Showing the difficulties in conveying and erecting the plant and its successful installation. 2500 w. Glückauf —Oct. 6, 1900. No. 37347 B.

Motors.

The Experimental Determination of the

Time Relation between Current and Pressure in Rotors of Asynchronous Motors. (Ueber die Experimentelle Bestimmung des Zeitlichen Verlaufes von Strom und Spannung im Rotor von Asychonmotoren). H. Rupp. Giving a detailed description of apparatus and experiments. 3000 w. Elektrotech Zeitschr—Oct. 4, 1900. No. 37355 B.

TRANSMISSION.

Copper Saving.

Copper Saving in the Joint Transmission of Direct and Alternating Currents. Frederick Bedell. Full paper read at the N. Y. meeting of the Am. Assn. for the Adv. of Science. Calculation of the saving that may be made in the weight of copper and in copper cores. 2100 w. Sib Jour of Engng—Oct., 1900. No. 37177 C.

High Tension.

Two European Direct-Current, High-Tension Transmissions. Frank C. Perkins. Brief illustrated description of the Isoverda-Genoa transmission, and that installed at Chaux-de-Fonds and Locle. 700 w. Jour of Elec—Sept., 1900. No. 37176.

Mine Transmission.

Mr. Heather's Paper on the Electric Transmission Plants at Moodie's Gold Mines. E. K. Scott. A review of paper concerning mines in South Africa. 1100 w. Elec Rev, Lond—Oct. 5, 1900. No. 37120 A.

Wave Form.

Effect of Wave Form on Capacity Current of Transmission Lines. F. G. Baum. Analytic study. 1000 w. Elec Wld & Engr—Oct. 20, 1900. No. 37215.

MISCELLANY.

Gravitation.

An Explanation of Gravitation. Reginald A. Fessenden. Considers it a secondary electric effect. 2000 w. Elec Wld & Engr—Sept. 29, 1900. No. 36902.

Nomenclature.

Nomenclature of Electrical Apparatus. Charles P. Steinmetz. Discusses needed improvements in terminology and nomenclature. 1500 w. Elec Wld & Engr—Oct. 20, 1900. No. 37212.

GAS ENGINEERING

Acetylene.

A New Acetylene Gas Generator. Illustrated description of an invention of Eugene Bournonville. 1400 w. Eng News—Oct. 4, 1900. No. 37006.

Some Facts About Purification of Acetylene Gas. Theodore Kautney. Read before the International Acetylene Assn. Shows that most of the troubles arises from impurities, and that getting rid of them will give a gas of superior quality. 1500 w. Dom Engng—Sept. 15, 1900. No. 36890 C.

The Best Method of Generating Acetylene; Water to Carbide, or Carbide to Water? J. A. Painchaud. Discusses the plunge system, and the sprinkling and immersion systems, advocating the carbide to water generators. 1000 w. Ir Age—Oct. 25, 1900. No. 37237.

Ammonia.

Sulphate of Ammonia in Comparison with Other Manures. James Muir. Considers the application of sulphate of ammonia on potatoes, beans, clover, grass land, etc. 4000 w. Gas Engs' Mag—Sept. 10, 1900. No. 36931 A.

Artificial Lighting.

The Development of Artificial Lighting. From the *Inst. of Civ. Engs.* Summary of an interesting article by Herr C. Kjaer, which appeared in *Ingenioren*, of Copenhagen. 1200 w. Jour Gas Lgt—Oct. 2, 1900. No. 37101 A.

Boule Light.

The Boule Light. Ernest Salzenberg. Read before the International Gas Congress, at Paris. Briefly reviews the methods of obtaining the heat energy of gas in the form of light, the apparatus used for increasing the light by means of increased pressure. 3800 w. Jour Gas Lgt—Oct. 2, 1900. No. 37099 A.

Burners.

Self-Lighting Gas-Burners. A review of articles by M. Pierron on the characteristics of some appliances for automatic ignition. Ill. 3000 w. Jour Gas Lgt—Oct. 16, 1900. No. 37252 A.

Calcium Carbide.

Calcium Carbide at the Congress of Applied Chemistry. Reviews papers on this subject read at Paris. 1600 w. Sci Am—Oct. 20, 1900. No. 37169.

Coal Gas.

Heating and Lighting Power of Coal Gas. T. Fairley. On some of the results obtained, and precautions needed to give trustworthy measurements. 900 w. Am Gas Lgt Jour—Oct. 29, 1900. No. 37297.

Coke Handling.

Mechanical Handling of Coke in the Paris Gas Company's Works. Abstract translation of paper by M. Louvel, giving illustrated detailed description of the plant. 3200 w. Gas Wld—Sept. 22, 1900. No. 36946 A.

The Mechanical Handling of Coal and Coke (Manntention Mécanique du Charbon et du Coke). J. Laverchère. A very complete illustrated account of the apparatus and methods at the works of the Paris Gas Company. Two articles, two plates. 6000 w. Génie Civil—Sept. 22, 1900. No. 37305 each D.

Consolidated Plant.

The Plant of the Faribault Consolidated Gas and Electric Company. Oliver Field Allen. Illustrated description of a plant in Minnesota. 2500 w. Engs' Year Bk., 1900—Univ of Minn. No. 36963 E.

Consumers.

An Unprofitable Consumer. Norton H. Humphrys. Discusses the use of slot-meters, fuel gas, etc., and how to convert an unprofitable customer into a profitable one. 3700 w. Jour of Gas Lgt—Oct. 2, 1900. No. 37096 A.

Fuel Gas.

Culm Banks and Fuel Gas. Alton D. Adams. An estimate of the cost of gas developed from the anthracite coal culm, and transmitted 50 miles. 2200 w. Sci Am—Oct. 13, 1900. No. 37070.

Furnace Gas.

Heat and Power from the Waste Gases of Blast Furnaces. F. W. Gordon. Discusses what amount of heat should be used for the blast furnace, and what would remain. Ill. 4000 w. Ir Age—Oct. 18, 1900. No. 37157.

Practical Considerations Involved in the Generation of Power by Blast Furnace Gas. Particulars of its working and of the results obtained in practice. 2000 w. Elec Rev, Lond—Sept. 28, 1900. Serial. 1st part. No. 37014 A.

Gas Engines.

See Mechanical Engineering, Special Motors.

Gas Manufacture.

Practical Notes on Gas Manufacture. S. Carpenter. Notes and facts from experience intended for help of those who have not had a liberal education. 2400 w. Jour Gas Lgt—Oct. 2, 1900. Serial. 1st part. No. 37097 A.

Gas Power.

The Use of Motors with Lean Gas (Emploi des Moteurs à Gaz Pauvre). Charles Thonet. An examination of the advantages of producer and water gas for motive power, especially in electric power and lighting stations. 4000 w. Rev Univ des Mines—Sept., 1900. No. 37340 G.

Gas Stoves.

Faults in Gas Stoves for Heating Baths. A. Gartner. Investigations leading to the conclusion that gas stoves and bath heaters, without adequate ventilation, in small rooms, involve a direct danger to life. 2200 w. Gas Engs' Mag—Oct. 10, 1900. No. 37249 A.

Gas Supply.

A Sketch of the History of the Gas Supply of New York. The present article reviews the subject up to the close of the Civil War. 2800 w. Jour Gas Lgt—Oct. 2, 1900. Serial. 1st part. No. 37095 A.

Globes.

Welsbach Lamp Globes and Reflectors. Reports results of tests made as to the distribution and diffusion of light by different globes used in conjunction with Welsbach mantles. Robert Williamson and Henry Klinck, in the *Journal des Usines à Gaz*. Ill. 1000 w. Gas Wld—Sept. 29, 1900. No. 37018 A.

Illuminants.

The Use of Hydrocarbons as Illuminants in Competition with Gas. A. Lecomte. Read before the International Gas Congress, at Paris. Treats of lighting by volatile hydrocarbons, distributed at the ordinary temperature. 4200 w. Jour Gas Lgt—Oct. 16, 1900. No. 37251 A.

Illuminating Gas.

Manufacture of Illuminating Gas. The present article is an illustrated description of the methods used at the 14th St. Station, New York. 2700 w. Sci Am—Oct. 6, 1900. Serial. 1st part. No. 36929.

Illumination.

Systems of Illumination Graphically Compared. Ad. Bouvier. Read before the International Gas Congress, at Paris. Gives the facts to be expressed and explains how this is done graphically. 800 w. Jour Gas Lgt—Oct. 16, 1900. No. 37250 A.

The Illumination Problem Again. W. H. Birchmore. A criticism of various papers that have dealt with this subject. 2500 w. Am Gas Lgt Jour—Oct. 15, 1900. No. 37159.

Mantles.

The Incandescent Gas Mantle and Its Uses. Vivian B. Lewes. This first lecture reviews the development and history of mantles. 5200 w. Jour Soc of Arts—Oct. 19, 1900. Serial. 1st part. No. 37280 A.

Meters.

Dry Meters, Their Advantages and Defects. Abstract translation of paper by W. Asselbergs. Comparison of wet and dry meters, with illustrated description of the Haas meter. 2200 w. Gas Wld—Sept. 22, 1900. No. 36947 A.

Results with Prepayment Meters in Holland. P. Bolsius. Read before the International Gas Congress, at Paris. Particulars of results attending the adaption of this system. The general conclusion is favorable. 2500 w. Jour Gas Lgt—Sept. 25, 1900. No. 36978 A.

Wet and Dry Meters. P. Bigeard. Read before the International Gas Congress, at Paris. A discussion of the two methods, their advantages and disadvantages. 1500 w. Jour Gas Lgt—Oct. 2, 1900. No. 37098 A.

Paris Exhibition.

Gas-Generating Plant at the Paris Exposition. Brief description of a model exhibited in the German section at the Champ de Mars. 1100 w. Sci Am—Oct. 27, 1900. No. 37242.

Paris.

Public Lighting in Paris. Auguste Levy. Brief review, especially of recent work. 2200 w. Gas Wld. Oct. 6, 1900. No. 37132 A.

Price.

Governmental Control of the Price of Gas. Alfred E. Forstall. Read at Denver meeting of Am. Gas Lgt. Assn. Reviews the systems of regulation prevailing in various places. 4200 w. Am Gas Lgt Jour—Oct. 29, 1900. No. 37296.

Retorts.

Inclined Retorts at Cambridge. Richard Brown. Read before the Eastern Counties' Assn., England. Illustrated description of the installation and report of working. Also discussion. 4000 w. Gas Wld—Sept. 22, 1900. No. 36945 A.

Separate Gas Producers for the Heating of Retort-Benches. G. Eichehbrenner. Read before the International Gas Congress, at Paris. Illustrates and describes an installation near some coal mines, in grounds undergoing subsidence, and discusses the advantages and disadvantages of the system adopted. 1500 w. Jour Gas Lgt—Sept. 25, 1900. No. 36977 A.

Stokers.

Methods for Giving Stokers an Interest in Their Work. I. Hedde. Read before the International Gas Congress, at Paris. Considers the technical means, general methods of arousing interest. giving an account of the means employed and the proposed solution. 5500 w. Jour Gas Lgt—Oct. 2, 1900. Serial. 1st part. No. 37100 W.

Water Gas.

Water Gas in Comparison with other Combustible Gases (Wassergas im Vergleich mit andern Brennbaren Gasen). Joh. Körting. An examination of gases used both for power and illumination, especially the former, showing under what conditions water gas may be advantageously used. Two articles. 7500 w. Zeitschr d Ver Deutscher Ing—Sept. 29, Oct. 6, 1900. No. 37328 each D.

On Water Gas. Henri Sospisio. Abstract of paper read at the Paris Congress. Discusses the Strache, and the Dellwik-Fleischer generators, and points of importance in the manufacture of water gas. Ill. 3000 w. Gas Wld—Oct. 20. 1900. No. 37288 A.

MARINE AND NAVAL ENGINEERING

Armor.

See Mining and Metallurgy, Iron & Steel.

Construction.

Changes in Vessel Construction in Forty Years of Lloyd's Register. B. Martell. Read before the Inst. of Naval Archts., London. A summary of the changes and developments in the construction of ships for the mercantile marine. 5800 w. Marine Engng—Oct., 1900. No. 37049 C.

Cruisers.

H. M. S. "Essex." Illustrated description. with comparison of the powers of offence and defence with the "Bayou" and "Prinz Heinrich." 2000 w. Engr, Lond—Oct. 12, 1900. No. 37222 A.

The German Armored Cruiser "Prinz Heinrich." Illustrated description, with comparison with other vessels. 1200 w. Engr, Lond—Sept. 21, 1900. No. 36956 A.

"Deutschland."

Additional Particulars of the New Transatlantic Record Breaker "Deutschland." Gives detail dimensions of the machinery and interesting views of the hull, with other information. 2000 w. Marine Engng—Oct., 1900. No. 37048 C.

Ferryboat.

New Type of Western River Ferryboat. William H. Bryan. From the official proceedings of the St. Louis Railway Club. An illustrated description of the "Andrew Christy." with review of types and progress. 4000 w. Naut Gaz—Sept. 27, 1900. No. 36904.

Freight Steamers.

Freight Steamers "Paraguay" and "Asuncion," Built on the Great Lakes for Atlantic Coasting Trade. Plans and brief description. 500 w. Marine Rev—Oct. 4, 1900. No. 37060.

French Navy.

The French Navy. A brief illustrated review showing the diversity of design and the unique character of the ships. 2000 w. Sci Am Sup—Oct. 6, 1900. No. 36930.

Great Lakes.

A Short History of the Lakes. Mary D. Hartt, in *Boston Transcript*. An ac-

count of the development of the great fresh water fleet on these lakes. 3200 w. Marine Rev—Sept. 27, 1900. No. 36906.

Marine Engines.

See Mechanical Engineering, Steam Engineering.

Merchant Marine.

German Merchant Marine at the Paris Exhibition. An illustrated description of the pavilion and the objects exhibited within, which represent the development of the German merchant marine during the last fifteen years. 4200 w. Engng—Oct. 12, 1900. No. 37185 A.

The Russian Mercantile Marine. Information from a report of the British Consul, with regard to the shipping of Odessa and the Russian mercantile marine. 1000 w. Engng—Oct. 5, 1900. No. 37111 A.

Rapid Fire.

Rapid-Fire Guns (Canons à Tir Rapide). G. Canet. A paper read before the French Society of Civil Engineers reviewing the progress made since the exposition of 1889. 3500 w. Mem Soc Ing of Civ de France—Sept., 1900. No. 37341 G.

Report.

Admiral Melville's Report. Abstract of report to the Secretary of the Navy, urging a liberal appropriation that will enable the U. S. to keep abreast with other naval powers, and indicating some of the needs. 3000 w. Ir Age—Oct. 25, 1900. No. 37236.

Real Admiral Hichborn's Report. Reviews this exhaustive report on the development of the navy. 1900 w. Marine Rev—Oct. 25, 1900. No. 37269.

Statistics.

Naval Statistics. Statistics of the four principal naval powers of Europe, with comparison. 3000 w. Engng—Oct. 12, 1900. No. 37186 A.

Ore Transportation.

Transportation of Lake Superior Ores. Waldon Fawcett. An illustrated account of the ore-carrying vessels, handling cargoes, railways, etc. 2200 w. Mod Mach—Oct., 1900. No. 36983.

Schooner.

A Five-Thousand-Ton Wooden Schooner. Illustration of what is believed to be the largest wooden sailing vessel ever built, the "Pretoria," of Bay City, Mich. 600 w. Marine Engng—Oct., 1900. No. 37050 C.

Shipbuilding.

Shipbuilding in Germany. George Crouse Cook. Illustrates and describes an ice-breaking pilot steamer building at Kiel for service at the Kertsch, which connects the Black Sea with the Azof. 1800 w. Marine Rev—Sept. 27, 1900. No. 36905.

Speed Trials.

Speed Trials of the New British Royal Yacht "Victoria and Albert." Report of recent trials, which were satisfactory. 800 w. Marine Engng—Oct., 1900. No. 37045 C.

Steamships.

The Cunard Liner "Ivernia." Longitudinal section and deck plans, with brief description. 800 w. Engng—Sept. 21, 1900. No. 36948 A.

Submarine.

Submarine Boats—From the Earliest Records Down to the Present. Carl Burley. Translated from the Pro. of the German Soc. of Nav. Archts. and Marine Engs. Illustrated historical review. 2800 w. Marine Engng—Oct., 1900. Serial. 1st part. No. 37046 C.

Submarine Navigation (La Navigation Sous-Marine). H. Noalhat. A discussion of the space required for motors operated by steam, electricity, compressed air, and petroleum, respectively, for use in submarine boats. 1500 w. Revue Technique—Oct. 10, 1900. No. 37317 D.

Tugs.

New Steel Harbor Tug. Description of the "John K. Cowen," with illustration. 1000 w. Naut Gaz—Oct. 4, 1900. No. 37001.

U. S. Laws.

U. S. Laws Regulating the Importation of Materials for the Construction and Repair of Vessels. Gives opinions and rulings in recent cases, and which are accepted as the law at the present time. 2500 w. Marine Engng—Oct., 1900. No. 37047 C.

Warships.

Modern Warships (Les Marines de Guerre Modernes). M. de Chasseloup-Laubat. An exhaustive review of the vessels of various naval powers. This issue covers the British navy. 20000 w. Bull Soc d'Encour—Sept., 1900. No. 37335 G.

"Wisconsin."

trates and describes the vessel, and reports Trial Trip of the "Wisconsin." Illustrates the fastest battleship in the American Navy. 2000 w. Marine Rev—Oct. 18, 1900. No. 37219.

Yachts.

Yacht Designing. Theodore Lucas. Briefly discusses the appearance, general arrangements, ornamentation, stability, strength, etc. 1400 w. Naut Gaz—Oct. 11, 1900. No. 36980.

MECHANICAL ENGINEERING

AUTOMOBILISM.

Acetylene Motors.

Acetylene in Explosion Engines. Discusses the advantages and disadvantages of this gas in reference to its use for the propulsion of motor vehicles. 2100 w. Auto Jour—Sept., 1900. No. 36933 A.

Automobile Facts.

The Electric Automobile from a Commercial Point of View. Robert A. Fliess. The first part of a report aiming to determine as accurately as possible the commercial standing of the electric automobile at the present time. 6000 w. Elec Wld & Engr—Oct. 6, 1900. Serial. 1st part. No. 37051.

Construction.

Automobile Construction and Constructors. Thomas Clarkson. Discusses some of the difficulties met, the choice of motive power, wheel construction, etc. 2200 w. Horseless Age—Oct. 17, 1900. No. 37175.

The Final Automobile. Hugh Dolnar. The first of a series of six papers dealing with the primal mechanical requirements of automobiles. This paper considers permanent bearings. Ill. 4000 w. Auto Mag—Oct., 1900. No. 37211 C.

Electric Coupe.

Working Drawing of Electric Coupé. From *The Hub*. Shows how to construct the body, battery box and the gear in proportions to insure safety. 2000 w. Sci Am Sup—Oct. 20, 1900. No. 37173.

Exhibition.

The *Inter-Ocean* Tournament. E. C. Oliver. Reviews the exhibits of the automobile exhibition at Chicago. Ill. 1100 w. Horseless Age—Sept. 26, 1900. No. 36908.

Fire Automobiles.

The Electric Fire Automobiles of the Paris Fire Department. Brief illustrated description, including hook and ladder, fire-pump, and hose cart. 1200 w. Sci Am—Oct. 27, 1900. No. 37244.

Gasoline Motors.

Gasoline Automobiles. William Baxter, Jr. Illustrates and describes the principle on which gasoline motors act, and various applications to vehicles. 3400 w. Pop Sci M—Oct., 1900. No. 36976 C.

History.

The Genesis of the Automobile. A. Neuberger. Brief historical review showing the idea of mechanically propelled vehicles dates back to the time of the Pharaohs. 1300 w. Auto Mag—Oct., 1900. No. 37210 C.

Military.

The Automobile in Modern Warfare. From *L'Illustration*. Illustrates and describes the vehicles used in recent manœuvres of the French army. The traction engines gave the most satisfactory results. 1000 w. Sci Am Sup—Oct. 13, 1900. No. 37071.

Motor Car.

The Rochet Motor Car. From *The Motor Car Journal*. Illustrated detailed description. 1200 w. Sci Am Sup—Oct. 27, 1900. No. 37247.

Paris Exhibition.

Automobiles at the Paris Exhibition. G. F. Desjaques. Gives a brief review of the automobile history of France, showing why steam has fallen into disfavor, as introductory to a very complete review of the interesting exhibits in this field. 3000 w. Engng—Oct. 19, 1900. Serial. 1st part. No. 37270 A.

The Paris Exhibition. Illustrated description of the more important exhibits of motor vehicles. 11800 w. Auto Jour—Oct., 1900. No. 37238 A.

Resistance.

Resistance of Road Vehicles to Traction. Abstract of a paper read by Prof. Hele-Shaw before the British Assn. On the need of investigation and proposed experiments, with brief report of preliminary experiments. 1700 w. Auto Jour—Sept., 1900. No. 36935 A.

Steam Truck.

The Cunningham Steam Truck. Illustrated description of a vehicle for heavy haulage. 2300 w. Horseless Age—Oct. 3, 1900. No. 36995.

Trials.

Heavy Motor Car Trials in Paris. An account of recent trials in which ten vehicles competed, comprising four steam cars, five petrol vehicles, and one electric van. Ill. 3800 w. Engr, Lond—Oct. 19, 1900. No. 37275 A.

Working Costs.

Some Actual Working Costs of Motors for Street Watering and Dust Removal. E. Shrapnell Smith. Read before the Assn. of Cleansing Supts. of Gt. Britain. Excerpt. A report of recent results justifying the use of motor vehicles for the purposes named. 2100 w. Auto Jour—Sept., 1900. No. 36934 A.

HYDRAULICS.

Hydraulic Power.

The New Hydraulic Electric Power Plant of Stuttgart at Marbach on the Neckar (Die Neue Wasserkraft Anlage

des Elektrizitätswerkes Stuttgart zu Marbach a. N.). Describing the plant by which 2,000 h. p. is generated at Marbach and transmitted about 12 miles to Stuttgart. 1000 w. Deutsche Bauzeitung—Sept. 29, 1900. No. 37371 B.

The Value of Water Power for Electrochemical Industries (Die Verwertung von Wasserkräften für Elektrochemische Zwecke). Oscar von Miller. A detailed analysis of the value of electricity in chemical industry, for water powers of various costs. 5000 w. Zeitschr f Elektrochemie—Oct. 11, 1900. No. 37370 G.

The Hydraulic Power of the Alps (Les Forces Hydrauliquies des Alpes). René Tavernier. The very full report of the French government commission giving statistics, suggestions as to the utilization, and legislation, for France, Italy, and Switzerland. 25000 w. Map. Ann des Ponts et Chaussées—2 Trimestre, 1900. No. 37322 E + F.

Pump Foundations.

Suggestions Concerning Foundations. Henry H. Kelley. Illustrations and observations concerning construction and cost. 1200 w. Engr, U. S. A.—Oct. 1, 1900. No. 36928.

Water Lifting.

Advantages and Disadvantages of Various Motors for Raising Water to Elevations for Domestic Use. Discusses the windmill, the hydraulic ram, the electric motor, and the hot-air engine. 3300 w. Dom Engng—Sept. 15, 1900. No. 36889 C.

Water Motors.

Report upon Exhibits Class 20, at the Paris Exposition (Bericht über die Objekte der Klasse 20, "Diverse Motoren" an der Weltausstellung in Paris, 1900). F. Prasil. Especially devoted to the study of turbines and regulators exhibited at Paris. Serial. Part I. 3000 w. Schweizerische Bauzeitung—Sept. 29, 1900. No. 37332 B.

Wood Pipe.

Nine-Foot Wood Stave Pipe, Floriston Pulp and Paper Co., Floriston, Cal. D. C. Henry. Illustrated description of this pipe and its construction, and the power-plant supplied. 1200 w. Eng News—Oct. 4, 1900. No. 87007.

MACHINE WORKS AND FOUNDRIES.

Automatic Stop.

Adjustable Automatic Feed Release for Turret Lathes. Illustrates and describes an interesting adjustable device. 600 w. Am Mach—Oct. 25, 1900. No. 37234.

Cranes.

Electric Traveling Cranes in the Foundry. A. D. Williams. Read before the Foundry Men's Assn. Considers the multimotor electric crane from the user's standpoint, its desirable and undesirable features. 3500 w. Ir. Trd Rev—Oct. 4, 1900. No. 36999.

The Stability of Locomotive Cranes. J. V. McAdam. Develops formulas for use and gives graphical plot for finding the weight of the crane. 1200 w. Sib Jour of Engng—Oct., 1900. No. 37180 C.

Files.

Making Chisels and Other Tools from Files. Walter J. May. Suggestions as to the proper treatment to secure good tools. 1400 w. Prac Engr—Oct. 12, 1900. No. 37205 A.

Gear Teeth.

The Bilgram Machine for Cutting Gear Teeth. Drawings and description, taken from letters patent recently issued. 2200 w. Ir Age—Oct. 11, 1900. No. 37068.

Lathes.

A Novelty in Lathe Design. Illustrates and describes a novel universal lathe made in Germany. 1800 w. Am Mach—Oct. 18, 1900. No. 37166.

Machine Driving.

See Electrical Engineering, Power Applications.

Mandrel.

Expansion Mandrel for Piston Rings. George R. Martin. Illustrated description. 300 w. Am Mach—Oct. 4, 1900. No. 36996.

Melting.

Hot Iron. Edward Kirk. The effects of rapid and slow melting are discussed, and the foundry sense of the term "hot iron." 1200 w. Foundry—Oct., 1900. No. 36959.

Pipes.

Pipe Founding. Eliot A. Keeler. Read at meeting of the Foundrymen's Assn. A review of American practice. Ill. 1600 w. Foundry—Oct., 1900. No. 36960.

Riveted Joints.

General Formulas for Efficiency and Proportions of Riveted Joints. John H. Barr. Considers single riveted lap joints, double riveted lap joints, double and triple riveted butt joints, two welts, and general equations. 1600 w. Sib. Jour of Engng—Oct., 1900. No. 37179 C.

Rolling Mills.

See Mining and Metallurgy, Iron & Steel.

Scrap.

Railroad Scrap. J. A. Carney. Discusses a method of handling machine-shop scrap from the time it is made until loaded for shipment. 1300 w. St. Louis Ry Club—Oct. 12, 1900. No. 37406.

Screws.

On Screw Threads Used in Cycle Construction, and for Screws Subject to Vi-

bration. O. P. Clements. Read before the British Assn. Discusses the shape of the threads. 1200 w. Engr, Lond—Sept. 21, 1900. No. 36958 A.

Shafts.

Repairing Multiple Eccentric Shafts. Walter J. May. Brief illustrated description of method. 700 w. Prac Engr—Oct. 19, 1900. No. 37283 A.

Sheet Metal.

Pressure and Power Required to Roll Sheet Metal. W. P. Richardson and E. K. Weimerlund. An account of experimental investigations. Ill. 1800 w. Engs' Year Bk., 1900—Univ of Minn. No. 36-968 E.

Shops.

The Shops and Manufacturing Methods of the Hendey Machine Company. Illustrated detailed description of shops located at Torrington, Conn. 5400 w. Mach, N. Y.—Oct., 1900. No. 36911.

Steel Castings.

Steel Castings at the Exposition of 1900 (Les Aciers Moulés à l'Exposition de 1900). A. Abraham. A discussion of the present state of the art as shown by the exhibits at Paris, both of methods and products. Two articles, 4000 w. Génie Civil—Sept. 15, 22, 1900. No. 37-302 each D.

Tubes.

Casting Solid Pipe Ingots for Drawing Tubes. Walter J. May. Suggestions that may be helpful in producing good castings. 1500 w. Prac Engr—Sept. 28, 1900. No. 37016 A.

Turret Lathes.

Turret Lathe Work at the Paris Exhibition. Reviews the most interesting of the exhibits and remarks on the degree of progress shown. Ill. 2300 w. Engng—Oct. 19, 1900. No. 37272 A.

Worm-Gearing.

The Action of Evolute and Cycloidal Teeth in Worm Gearing (Eingriffverhältnisse der Schneckengetriebe mit Evolventen und Zykloidenverzahnung). Ad. Ernst. A very full examination into the duration and nature of contact in various cases, with especial reference to the question of wear. Serial, Part I. 6000 w. Zeitschr d Ver Deutscher-Ing—Sept. 15, 1900. No. 37327 D.

MATERIALS OF CONSTRUCTION.

Aluminum.

Aluminum: Considered Practically in Relation to Its General Application in the Arts and Mechanics. Joseph A. Steinmetz. Enumerates the uses that have proved satisfactory and cautions the improper use of the metal. 4500 w. Jour Fr Inst—Oct., 1900. No. 36993 D.

Cast Iron.

See Mining and Metallurgy, Iron and Steel.

Rupture.

Deformation and Conditions of Rupture (Déformations et Conditions de la Rupture). Harel de la Noé. A mathematical examination of the behavior of solid bodies under stresses beyond the elastic limit, based upon the experiments of Commandant Hartmann. 8000 w. Ann des Ponts et Chaussées—2 Trimestre, 1900. No. 37323 E + F.

Specifications.

American Standard Specifications and Methods of Testing Iron and Steel. Albert Ladd Colby. Read before the Iron and Steel Inst. A critical review of the requirements, as indicated by American manufacturers. 7300 w. Ir & Coal Trds Rev—Sept. 21, 1900—No. 36953 A.

POWER AND TRANSMISSION.

Conveying Machinery.

"Otto" Wire Rope Tramway at a German Steel Works. Illustrated description of a rope tramway at the Hoesch Iron and Steel Works, Dortmund, for conveying coke to the blast furnaces. 800 w. Col Guard—Oct. 12, 1900. No. 37-191 A.

Rolling Screw Conveyors. An illustrated discussion of the method of manufacturering spiral conveyors, and recent improvements made. 2000 w. Am Mach—Oct. 25, 1900. No. 37235.

Furnace Gas.

See Gas Engineering.

Power Generation.

Power Generation by Steam Engine, Water Turbine, and Gas Engine. Extract from paper by John B. C. Kershaw, read before the British Assn. The portion relating to gas-engines, and the conclusions of the writer. 1800 w. Jour Gas Lgt—Sept. 25, 1900. No. 36982 A.

Pulleys.

A Remarkable Test of a Wooden-Rim Pulley. Illustrated description of the construction of a pulley, and its test to a rim-speed of 5½ miles per minute without destruction. 800 w. Eng Rec—Oct. 13, 1900. No. 37143.

SPECIAL MOTORS.

Acetylene Motors.

See Mechanical Engineering, Automobilism.

Benzine Motors.

Studies in the Efficiency of Benzine Motors for Vehicles (Leistungsversuche an Fahrzeug-Benzinmotoren). Hugo Güldner. Giving details of the testing apparatus and data of tests upon benzine motors of motor cycles. Serial, Part I.

2500 w. Zeitschr d Ver Deutscher Ing—Sept. 29, 1900. No. 37329 D.

Gas Engines.

Fuel for Gas Motors. Aimé Witz. Read before the International Gas Congress, at Paris. Statements concerning the various gases used, and improvements made. 2000 w. Jour Gas Lgt—Sept. 25, 1900. No. 36979 A.

Gas Engine Design. E. J. Stoddard. Discusses the explosive mixture and ignition. Ill. 2200 w. Mod Mach—Oct., 1900. No. 36985.

Gas Engine Economy. E. W. Roberts, in *The Gas Engine*. Calling attention to needed improvements and means of securing the maximum economy. 1800 w. Min & Sci Pr—Oct. 5, 1900. No. 37077.

The Gas Engine of the Paris Exposition. Illustrated detailed descriptions of types exhibited. 4000 w. Power—Oct., 1900. No. 36923.

Gasoline Engines.

Gasoline Engines in the Philippines. Hints to exporters, illustrating changes made by native workmen, and the incorrect erection of the machines. 2100 w. Am Mfr & Ir Wld—Oct. 25, 1900. No. 37295.

Gas Power.

See Gas Engineering.

Internal Combustion.

Some Recent Developments in the Internal Combustion Engines. John A. Secor. Discusses progress in the use of gas and oil engines. Also general discussion. 11800 w. N. Y. R R Club—Sept. 20, 1900. No. 37119.

Paris Exhibition.

Gas and Oil Engines at the Paris Exhibition. Remarks on the leading types and a detailed description of the chief exhibits. 2800 w. Engr, Lond—Oct. 12, 1900. Serial. 1st part. No. 37221 A.

STEAM ENGINEERING.

Accidents.

Accidents with Steam Boilers in 1898 (Des Accidents d'Appareils à Vapeur Survenus pendant l'Année 1898). The official French tabulated report, with plates of details of explosions and other accidents. 5000 w. 3 plates. Ann des Ponts et Chaussées—2 Trimestre, 1900 No. 37324 E + F.

Can Boiler Explosions Be Prevented? W. H. Wakeman. Discussion of the causes of explosions, and precautions that should be taken. 3600 w. Mod Mach—Oct., 1900. No. 36984.

Boilers.

Feed Water and Boilers. A discussion of the nature of water supply, and a comparison showing that under certain conditions, one type of boiler may prove satisfactory, while other types may not be adapted to the conditions. 1600 w. Locomotive—Sept., 1900. No. 37166.

Objectionable Matter Which Tends to Enter Steam Boilers, and Its Prevention from So Doing. W. W. Houfe. Read before the Inst. of Marine Engs. Deductions from the writer's experience. 2200 w. Prac Engr—Oct. 19, 1900. Serial. 1st part. No. 37282 A.

The Design of Tubular Boilers. Charles L. Hubbard. Plain directions from the standpoint of engineers and architects. 2300 w. Mach, N. Y.—Oct., 1900. Serial. 1st part. No. 36912.

The Joya Water Tube Boiler (Chaudière Aquitubulaire Système Joya). An improved boiler resembling the Niclausse, but with simplified connection of tubes. 1000 w. Revue Technique—Oct. 10, 1900. No. 37316 D.

The Steinmuller Boiler (Der Steinmuller Kessel). Especially devoted to a description of the Steinmuller exhibit at the Paris Exposition. 1800 w. Glaser's Annalen—Oct. 1, 1900. No. 37337 D.

Chimneys.

See Architectural Engineering.

Compound Engines.

Paris Exhibition—Compound Engine. Illustrated description of the new compound electric light engine exhibited by Robey & Co., Limited. 900 w. Engr, Lond—Sept. 21, 1900. No. 36955 A.

Cylinder Condensation.

Observations on an Improved Glass Revealer, for Studying Condensation in Steam-Engine Cylinders, and Rendering the Effects Visible. Bryan Donkin. General description, with account of experiments and results. Also a communication by M. Nadal. Ill. 6300 w. Inst of Mech Engs—Oct. 19, 1900. No. 37405 D.

Governors.

Note on Theory of Corliss Governors. C. V. Kerr. Explains a method of reducing the labor of finding the values of certain variables. 500 w. Stevens Ind—Oct., 1900. No. 37404 D.

High-Speed Engines.

High-Speed Reciprocating Engines. Allan Coats. Read before the Glasgow Tech. Col. Sci. Soc. A detailed study of this class, discussing in the present article the subjects of leakage, port design, lubrication, steam v. air buffers, etc. Ill. 4000 w. Elec Engr, Lond—Oct. 5, 1900. Serial. 1st part. No. 37125 A.

The Mertz High-Speed Steam Engines (Machines à Vapeur à Grande Vitesse Système E. Mertz). The Mertz balanced engine has two opposing pistons in each cylinder, enabling high speeds to be obtained without vibration. 1500 w. Génie Civil—Oct. 13, 1900. No. 37311 D.

Locomotive Boiler.

See Railway Affairs, Motive Power.

Marine Engines.

The Quadruple-Expansion Engines of the Cunard Liner "Ivernia." Illustrated description. 800 w. Engng—Oct. 5, 1900. No. 37110 A.

Pulverized Coal.

Burning Pulverized Coal. Describes the experiments being conducted by the Illinois Cent. Ry. Co., with apparatus for burning bituminous coal in a pulverized state, to ascertain whether the method would limit the smoke production and prove economical. Results are not yet available. Ill. 1500 w. Ry & Engng Rev —Oct. 6, 1900. No. 37056.

Pumping Engine.

Performance of the Twelve-Million-Gallon Allis Pumping Engine at Hackensack, N. J., and Comparative Data from Tests of the Best Three Contemporary Pumping Engines. James E. Denton. Gives a general description of the engine, states requirements, and gives results of tests. 3800 w. Stevens Ind—Oct., 1900. No. 37400 D.

Traction Engines.

American Traction Engines for Russia. Illustrated description of engines made in California, to be used as a substitute for camel trains in hauling supplies to the mines in Russia. 1000 w. Engr, Lond—Sept. 28, 1900. No. 37025 A.

Valve Gear.

See Railway Affairs, Motive Power.

Vertical Engines.

The 3,000-Horse-Power Engines of the Luisenstrasse Central Station, Berlin. Illustrated description from *Zeitschr d. Ver. Deutscher Ing.*, of three vertical, direct-connected, triple-expansion engines, with the results of a test of one of them, using steam with and without super heat. 2200 w. Eng Rec—Oct. 13, 1900. No. 37140.

MISCELLANY.

Aeronautics.

Pegasus. Discusses the balloons of Count Zeppelin and M. de Santos Dumont. Ill. 2300 w. Auto Jour—Sept., 1900. No. 36932 A.

The First Two Trial Trips of von Zeppelin's Airship. Illustrations and brief account of ascensions and evolutions, showing advancement of great interest to aeronautics. 1600 w. Sci Am Sup—Oct. 27, 1900. No. 37246.

Education.

Training for Competition with the World. Presidential address of R. H. Smith before the Civ. and Mech. Engs. Soc., England. 6000 w. Engr, Lond—Oct. 5, 1900. No. 37118 A.

Engineer's Note-Book.

An Engineer's Private Note Book. John H. Gregory. Describes a method of preserving notes which permits their ready classification, binding, and duplication by blue-printing. 1300 w. Eng Rec —Oct. 13, 1900. No. 37144.

Induction Jets.

A New Theory of Induction Jets (Nouvelle Théorie des Trompes). A. Rateau. A mathematical and general discussion of the action of hydraulic jets for inducing currents of water or air, with the results of many experiments. An important paper. 15000 w. Revue de Mécanique—Sept., 1900. No. 37336 H.

Paris Exhibition.

The Paris Exhibition: Its Lessons and Suggestions for Engineers. Abstracts of papers read at meeting of the Manchester (Eng.) Assn. of Engs. 2000 w. Col Guard—Oct. 19, 1900. No. 37276 A.

Rotary Motion.

The Determination of Irregularities in the Motion of Rotary Machines by Use of the Tuning Fork (Die Bestimmung des Ungleichförmigkeitsgrades Rotirender Maschinen durch das Stimmgabel verfahren). F. Göpel. The vibrations of the fork give a determinate basis for comparison. Serial, Part I. 3500 w. Zeitschr d Ver Deutscher Ing—Oct. 6, 1900. No. 37330 D.

Specifications.

The Ways of Consulting Engineers and Contractors. W. H. Booth. Why some engineers will not allow a specification to be departed from in any particular. 900 w. Am Mach—Oct. 11, 1900. No. 37075.

MINING AND METALLURGY

COAL AND COKE.

American Coal.

American Coal in Great Britain. Reprints of articles appearing in the British papers, in reference to the introduction of American coal. 1500 w. U. S. Cons Repts, No. 850—Oct. 4, 1900. No. 36991 D.

United States Coal in Marseilles. Extracts from the annual report of the consul, concerning the coal exported from America and other countries. 1500 w. U. S. Cons Repts, No. 850—Oct. 4, 1900. No. 36989 D.

United States Coal in Nantes. Consular report concerning this place as a market for American coal. 1200 w. U. S.

Cons Repts, No. 850—Oct. 4, 1900. No. 36990 D.

Anthracite.

The Anthracite Coal Trade. Waldon Fawcett. Figures on the output, showing its importance and the effect the strike may have on commerce. 2000 w. Am Mfr & Ir Wld—Sept. 27, 1900. No. 36922.

China.

Tong Colliery, Kaiping, North China. Thomas Webster. Read before the South Wales Inst. of Engs. Describes this colliery, the method of working, ventilation, haulage, etc. 3500 w. Col Guard—Oct. 5, 1900. No. 37114 A.

Coal Question.

The Burden of Coal. Benjamin Taylor. A detailed discussion of the coal question in England, showing its vital importance and where to look for relief. 5800 w. Nineteenth Cent—Sept., 1900. No. 36920 E.

Coke Handling.

See Gas Engineering.

Colliery Management.

The Relation of the Head and Colliery Offices. George Johnson. Brief description of methods and forms used in making reports. 800 w. Col Guard—Oct. 5, 1900. No. 37112 A.

Exports.

Coal Exports. Editorial on the present situation and the American coal question. 1700 w. Eng & Min Jour—Oct. 6, 1900. No. 37052.

Exposition.

Anzin Colliery at the Paris Exhibition. Describes the very interesting exhibit of this important French colliery. 3000 w. Col Guard—Oct. 19, 1900. No. 37277 A.

Vicoique et Noeux Collieries at the Paris Exhibition. Illustrated description of an electric locomotive and a compressed air hauling engine, with an account of the conditions they were made to satisfy. 3800 w. Col Guard—Oct. 12, 1900. No. 37188 A.

Fuel.

The Manufacture of Patent Fuel in Wales. Describes the agglomite process of manufacturing patent fuel from both the anthracite and bituminous mineral. 1500 w. U. S. Cons Repts, No. 852—Oct. 6, 1900. No. 36895 D.

India.

On the Makum Coalfield, Assam. George E. Harris. Read before the Manchester (Eng.) Geol. Soc. Describes these deposits, and reports the coal to compare favorably with best English coals. Also describes mining methods. 4000 w. Col Guard—Oct. 5, 1900. No. 37113 A.

Iowa.

Iowa Coal-Mining Methods. J. T. Beard. An account of the character of the coal, its influence on the methods of mining, and the systems in use. Ill. 1500 w. Mines & Min—Oct., 1900. No. 36882 C.

Italy.

Coal in Italy. Information concerning the sources of supply, and the amount of coal consumed. 900 w. U. S. Cons. Repts, No. 850—Oct. 4, 1900. No. 36988 D.

Michigan.

Pere Marquette Mines. R. A. Randall. Illustrated description of one of the largest and best equipped coal mines in the State of Michigan. 700 w. Mines & Min—Oct., 1900. No. 36875 C.

New Zealand.

The Puponga and Pakawau Coalfields, Collingwood County, N. Z. Alexander McKay. From the reports of the government geologist, giving an account of the coal-seams and analysis. 4000 w. N. Z. Mines Rec—Sept. 17, 1900. No. 37255 B.

The West Wauganui Coalfield. James Park. An account of the general geological structure and mineral resources. 3200 w. N. Z. Mines Rec—Sept. 17, 1900. No. 37256 B.

Philippines.

The Coal Fields of the Philippines. G. D. Rice. An account of extensive coal mines, some of which have been worked since 1827. The outlook for the establishment of gas works in the islands is favorably discussed. Ill. 3000 w. Am Gas Lgt Jour—Oct. 22, 1900. No. 37230.

Syndicate.

The Ten Years' Work of the Westphalia Coke Syndicate (Zehnjähriges Bestehen der Aktien-Gesellschaft "Westfalisches Kokssyndikät" zu Bochum). Reviewing the development of the coke industry in Westphalia, with instructive diagrams. 1200 w. 3 plates. Glückauf—Oct. 13, 1900. No. 37348 B.

Trams.

Colliery Trams. J. Fox Tallis. Read before the So. Wales Inst. of Engs. Calls attention to the various sorts and conditions of trams in use in the So. Wales coalfield, discussing their design. 2500 w. Ir & Coal Trds Rev—Sept. 28, 1900. No. 37023 A.

COPPER.

Analysis.

Volumetric Method for the Determination of Copper. Richard K. Meade. On the value of permanganate as a help to rapid analysis. 1000 w. Min & Sci Pr—Sept. 22, 1900. No. 36880.

Lake Huron.

Huronian Copper and Nickel. S. R. Clarke. Statement of the conditions and opportunities in Sudburry District. 1400 w. Am Mfr & Ir Wld—Oct. 4, 1900. No. 37058.

Montana.

Mining Practice in Butte, Montana, Copper Mines. R. B. Brinsmade. An account of the methods employed in the various operations, costs, etc. Ill.. 4600 w. Mines & Min—Oct., 1900. Serial. 1st part. No. 36878 C.

Wisconsin.

Copper Mining in Northern Wisconsin. Kirby Thomas. Read before the Mining Congress at Milwaukee. An account of the geology, discoveries and developments in the western Lake Superior copper region. 1700 w. Mines & Min—Oct., 1900. No. 36877 C.

GOLD AND SILVER.

British Columbia.

Similkameen Mining Division, Kamloops Mining District. W. M. Brewer. Description of this district, with other information related. 2800 w. Eng & Min Jour—Oct. 20, 1900. No. 37218.

Cape Nome.

The Great Storm at Nome. Winthrop Packard, in the N. Y. *Evening Post.* An account of a storm which wrecked a large part of the city. 1700 w. Eng & Min Jour—Oct. 13, 1900. No. 37153.

Cœur d'Alene.

Tunnel Development at Cœur d'Alene. W. C. Clark. A brief account of two cases of blind leads. 1000 w. Mines & Min—Oct., 1900. No. 36876 C.

Cripple Creek.

The Cripple Creek Mining District, Colorado. G. F. Hazlehurst. Geological map, with brief description of this district. 1100 w. Eng & Min Jour—Oct. 20, 1900. No. 37216.

Dredging.

Gold Dredging on Snake River in Idaho. F. Powell. Discusses the reasons for the numerous failures, the dredger used, cost, etc. Ill. 1800 w. Eng & Min Jour—Oct. 6, 1900. No. 37053.

The Saving of Fine Gold on Dredges. John Hayes. From the report of the Dept. of Mines on the Goldfields of New Zealand, for the year 1899-1900. Discusses the losses of gold in dredging, and means of overcoming the difficulty. 1500 w. N. Z. Mines Rec—Aug. 16, 1900. No. 36937 B.

Georgia.

Georgia Gold Mining Developments. Wilber Colvin. Historical review and report of recent work. Ill. 1300 w. Eng & Min Jour—Oct. 6, 1900. No. 37055.

Idaho.

The Boise (Idaho) Basin Mining District. Robert Nye. The history of this district, its geology, deposits, and general information. 2300 w. Min & Sci Pr—Oct. 6, 1900. No. 37076.

Mexico.

The Mines of Guanajuato, Mexico. Clara Spalding Brown. Illustrated account of the mines and their working. 2000 w. Min Rept—Oct. 11, 1900. No. 37147.

Ores.

Ore Buying. F. Danvers Power. Showing that much of the supposed unfairness of the smelter is imaginary. 3300 w. Aust Min Stand—Sept. 20, 1900. No. 37254 B.

Placers.

Exploiting a New Placer Field. Arthur Lakes. Some of the considerations to be taken account of, as illustrated at Fairplay, near Alma, Colorado. Ill. 2200 w. Mines & Min—Oct., 1900. No. 36883 C.

Silver.

Silver. R. N. Osbiston. Read before the Inverell (N. S. W.) Assn. of Mines. The first part is introductory to a description of processes used to extract silver at the Inverell mines. 1200 w. Aust Min Stand—Aug. 23, 1900. Serial. 1st part. No. 37019 B.

South Carolina.

The Haile Gold Mines. Arthur Lakes. Describes the machinery used for concentrating the ores, and for roasting and treating them by the chlorination process. 2500 w. Mines & Min—Oct., 1900. No. 36879 C.

IRON AND STEEL.

Armor.

Progress in the Manufacture of Armor Since 1889 (Progrés Réalisés dans la Fabrication des Blindages). E. Delmas. A review of the improvements due to the severe tests to which plates have been subjected, showing the great progress made in ten years. 2500 w. Mem Soc Ing Civ de France—Sept., 1900. No. 37343 G.

Bessemer Plant.

The Youngstown Bessemer Plant of the Republic Iron & Steel Company. Illustrated detailed description. 1100 w. Ir Age—Oct. 11, 1900. No. 37069.

Cast Iron.

The Influence of Aluminum on the Carbon in Cast Iron. Godfrey Welland and Harry W. Wardron. Read before the Iron & Steel Inst. An account of experiments to determine the amount of alumi-

num necessary to produce the maximum separation, and to ascertain the effect of slow and rapid cooling. Also discussion. Ill. 4000 w. Col Guard—Sept. 28, 1900. No. 37031 A.

France.

The Iron and Steel Industry of France. A report on the development and progress from 1888 to 1898. 3500 w. Ir Age—Oct. 4, 1900. No. 36924.

High Temperatures.

High Temperatures Produced by a New Method. Ernest F. Lange. Presented at the Paris meeting of the Iron and Steel Inst. A description of the Goldschmidt process. 4000 w. Ir Age—Oct. 4, 1900. No. 36925.

Limonite.

Limonite Ores of Pennsylvania. T. C. Hopkins. Their composition and forms, and an account of the various places in the State where they are mined. Ill. 3800 w. Mines & Min—Oct., 1900. No. 36-874 C.

Ore Transportation.

See Naval and Marine Engineering.

Paris Exhibition.

Iron and Steel at the Mineral Exhibition, Paris, 1900. H. Bauerman. A paper prepared as a guide to members of the Iron & Steel Inst. visiting the exhibition. 4000 w. Engr, Lond—Oct. 12, 1900. Serial. 1st part. No. 37223 A.

Phosphorus.

Iron and Phosphorus. J. E. Stead. Read before the Iron & Steel Inst. An account of researches and report of results of much interest. 6800 w. Engng—Oct. 19, 1900. Serial. 1st part. No. 37-273 A.

Rolling Mills.

Suggestions for the Improvement of Rolling Mills. Louis Katona. Read before the Iron and Steel Inst. Discusses defects of the present system, and the author's suggestions for a solution of the problem. 4000 w. Ir & Coal Trds Rev—Sept. 21, 1900. No. 36954 A.

Slag.

Blast Furnace Slag for Fertilizing. Alexander D. Elbers. Showing that it contains lime beneficial to the soil, and presenting the possible merits and essential points relating to its use. 2300 w. Am Mfr & Ir Wld—Oct. 11, 1900. No. 37102.

Solution Theory.

The Present Position of the Solution Theory of Carburized Iron. A. Stansfield. Abstract of paper read before the Iron & Steel Inst. Reviews the experimental evidence bearing upon this subject, and gives results of the writer's experiments. Ill. 1700 w. Ir & Coal Trds Rev—Sept. 28, 1900. No. 37022 A.

Steel.

The Manufacture of Steel. A review of pre-modern methods of manufacture is given in the present article. 2400 w. Auto Jour—Oct., 1900. Serial. 1st part. No. 37239 A.

Steel Castings.

See Mechanical Engineering, Machine Works and Foundries.

Trade.

A View of the Iron and Steel Trade. Walden Fawcett. Condensed from a monograph issued by the Treasury Dept. Bureau of Statistics of the United States. 3700 w. Eng & Min Jour—Oct. 27, 1900. No. 37266.

MINING.

Accidents.

Mining Labor and Accidents for the Year 1899. Particulars as to the number of persons employed and accidents at the mines and quarries of the United Kingdom. Ill. 3800 w. Col Guard—Sept. 21, 1900. No. 36952 A.

Cage-Loading.

Hydraulic Cage-Loading and Unloading Apparatus. G. B. Stones. Abstract of a paper read before the Inst. of Engs. Illustrated description of the surface and underground arrangements. 1200 w. Col Guard—Oct. 12, 1900. No. 37192 A.

Explosives.

The Use of Explosives in Mines. A copy of a recently issued circular to mine-owners, relating to the use of explosives in coal mines, with a list of the permitted explosives that have passed "special test." 2400 w. Col Guard—Oct. 12, 1900. No. 37189 A.

Life Saving.

Life-Saving Apparatus in Mines (Minen-Rettungsapparate). Johann v. Laues. A general discussion of devices for enabling life savers to penetrate gaseous and burning mines. Two articles, 1 plate. 3500 w. Oesterr Zeitschr f Berg u Hüttenwesen—Oct. 6, 13, 1900. No. 37345 each B.

Metal Mining.

American Metal Mining. Theodore F. Van Wagenen. The present article discusses the deposits of iron, their working and transportation. 2400 w. Min Rept—Oct. 4, 1900. Serial. 1st part. No. 37-074.

Mine Examination.

How Mines Should Be Examined. O. H. Parker. The writer's views, given for the purpose of calling out discussion. 1600 w. Eng & Min Jour—Oct. 20, 1900. No. 37217.

Mine Transmission.

See Electrical Engineering, Transmission.

Mining Law.

Loss of Remedy for Wrongful Uses of Way Leave, etc. A report of cases tried by British law, and a discussion of the decisions. 2400 w. Col Guard—Oct. 12, 1900. No. 37187 A.

The Mines Law of Ontario. Archibald Blue. Read before the mining congress, at Milwaukee. The provisions of the law in regard to prospecting and the acquiring of mining locations, etc. 3500 w. Mines & Min—Oct., 1900. No. 36884 C.

Wrongful Abstraction of Minerals: Measure of Damages. Report of cases and decisions in British courts. 2500 w. Col Guard—Sept. 28, 1900. No. 37030 A.

Mining Plant.

See Electrical Engineering, Power Applications.

Mining Tools.

Mining Tools in the Philippines. George D. Rice. Illustrates and describes some of the crude types used by the natives. 1400 w. Eng & Min Jour—Oct. 27, 1900. No. 37267.

Ore Testing.

Experimental Ore Testing Works. Arthur Lakes. Means for determining the proper method to be used in treating ores from a new mine, and the importance of tests. 1500 w. Mines & Min—Oct., 1900. No. 36881 C.

Pits.

On a New Method of Sinking Pits by Machinery. Richard Sutcliffe. Read before the Manchester, Eng., Geol. Soc. Illustrates and describes Sutcliffe's pit-sinking machine, and gives an account of its operation. 5200 w. Ir & Coal Trds Rev—Sept. 28, 1900. No. 37021 A.

Power Plant.

The Boise Basin (Idaho) Power Plant. Theo. F. Van Wagenen. Illustration and description of the construction is given in part first. 1000 w. Min Rept—Oct. 25, 1900. Serial. 1st part. No. 37299.

Rock Drills.

Machine Mine Rock Drills on the Pacific Coast. A. E. Chodzko. Brief description of the rock drills obtainable in San Francisco, and some facts relating to their use. 2500 w. Min & Sci Pr—Oct. 13, 1900. Serial. 1st part. No. 37167.

Rotary Converters.

Rotary Converters for Mine Traction. Alton D. Adams. Favoring their use as avoiding disadvantages incident to different classes of generating apparatus, and those that result from a high working pressure. 800 w. W Elect'n—Oct. 20, 1900. No. 37231.

Ventilation.

Influence on the Air-Current of Water Falling Down a Shaft. Paul Petit. From a communication to the International Min. Cong., at Paris. An account of investigations made to ascertain the mode of action of water thus falling, and to determine the amount of influence it may have on the total depression or water gauge. Ill. 3700 w. Col Guard—Sept. 28, 1900. No. 37032 A.

The Effect of Contractions in Area of Passages in Mine Ventilation. Paul Petit. Abstracted from paper read before the International Cong., at Paris. An account of tests and experiments, with conclusions. 2700 w. Eng & Min Jour—Oct. 13, 1900. No. 37154.

Wages.

Wages in the Mining and Quarrying Industries. Reviews the report to the Board of Trade of Great Britain on changes in rates of wages and hours of labor, giving tables showing variations. 1600 w. Col Guard—Oct. 12, 1900. No. 37193 A.

Winding.

The Koepe System of Winding. John Georgory and John T. Stobbs. Abstract of paper read before the Inst. of Min. Engs. Illustrates and describes this system at the Sneyd Colliery, Burslem, giving data relating. 800 w. Col Guard—Oct. 5, 1900. No. 37115 A.

MISCELLANY.

Address.

Presidential Address Before the Iron and Steel Institute, in Paris. On metallurgical progress in England and France. 3800 w. Engng—Sept. 21, 1900. Serial. 1st part. No. 36950 A.

Corundum.

On Two New Occurrences of Corundum in North Carolina. Joseph Hyde Pratt. Describes an occurrence in amphibole-schist, and another in a quartz-schist. 1800 w. Am Jour of Sci—Oct., 1900. No. 36962 D.

Petroleum.

Applications of Petroleum to Metallurgy and the Glass Industry. From *Le Génie Civil.* Illustrates and describes the Nobel smelting furnace, grate and reverberatory furnace; also the Quarnström portable forge and grate, and their applications. 2200 w. Sci Am Sup—Oct. 20, 1900. No. 37172.

Characteristics of California Petroleum. A. S. Cooper. Information regarding the constituents, characteristics, and other matters of interest. 3800 w. Min & Sci Pr—Oct. 13, 1900. No. 37168.

Paraffin in Russian Petroleum. A. A. Shukoff and N. S. Pantjucoff. From the *Petroleum Review.* A report of investi-

gations made by the writer. 900 w. Auto Jour—Oct., 1900. No. 37241 A.

The Geology of Petroleum (Zur Geologie des Erdöles). H. Höfer. An examination of the theory of Carll and a comparison of the conditions in Pennsylvania with those in various parts of Europe. 1200 w. Oesterr Zeitschr f Berg u Hüttenwesen—Oct. 13, 1900. No. 37346 B.

Philippines.

Mining in the Philippines. George D. Rice. Reports concerning the mineral deposits, and the interest being shown in them. 1500 w. Eng & Min Jour—Oct. 6, 1900. No. 37054.

Rare Metals.

Rare Metals and Minerals. J. Ohly. Considers metals found in nature in limited amounts, or whose production is combined with extraordinary difficulties. Among these, platinum, uranium, vanadium, tungsten and molybdenum. 3000 w. Ores & Metals—Oct., 1900. Special No. No. 37263 C.

Sardinia.

Mechanical Ore Preparation in Sardinia. N. Pellati. From a communication to the International Cong., at Paris. Describes some new appliances used in Sardinia, and little known outside of Italy. 1200 w. Col Guard—Oct. 12, 1900. No. 37190 A.

Tin.

Tasmanian Tinfields. H. Grant. An account of the Blue Tier, in Portland. 2200 w. Aust Min Stand—Sept. 13, 1900. No. 37264 B.

Tin Supplies. Editorial review of the situation, discussing values and activity in tin mining, sources of supply, etc. 1400 w. Engng—Oct. 19, 1900. No. 37271 A.

Zinc.

The Metallurgy of Zinc. J. Ohly. Brief review of past methods used in the production of zinc from its ores, and of those now in operation. 2400 w. Min & Sci Pr—Sept. 29, 1900. No. 36981.

RAILWAY AFFAIRS

CONDUCTING TRANSPORTATION.

Accidents.

Train Accidents in the United States in August. Detailed list and classified summary. 4000 w. R R Gaz—Oct. 5, 1900. No. 37010.

Train Accidents in the United States in September. Detailed list and classified summary for the month. 3500 w. R R Gaz—Oct. 26, 1900. No. 37265.

Wrecking.

Raising a Locomotive Fallen Into a Canal (Relevage d'une Machine Locomotive Tombée dans un Canal). Interesting illustrated account of the manner in which the locomotive was raised and the canal cleared. 1000 w. Génie Civil—Oct. 6, 1900. No. 37309 D.

FINANCIAL.

Statistics.

Statistics of the Railways of the United States in 1899. Reviews the last issues of Poor's Manual, and the Statistical Bureau of the Interstate Commerce Commission. 3000 w. Eng News—Oct. 11, 1900. No. 37106.

MOTIVE POWER AND EQUIPMENT.

Draft.

Draft Appliances. Showing how seriously the work of locomotives is affected by them. 1200 w. Loc Engng—Oct., 1900. No. 36918 C.

Electric Locomotive.

See Street and Electric Tramways.

Express Car.

Express Car for the Transportation of Horses. Drawings and description of specially designed cars for the N. Y. C. & H. R. R. R. 700 w. Am Engr & R R Jour—Oct., 1900. No. 36897 C.

Headlights.

Eyes and Headlights. On the value of strong headlights, with arguments for and against their use. 1500 w. R R Gaz—Oct. 12, 1900. No. 37094.

Journals.

Hot Journals. Translation of a review by Josef Grossmann, discussing the subject from the standpoint of oil pressures between bearing surfaces. Ill. 2400 w. Am Engr & R R Jour—Oct., 1900. No. 36899 C.

Locomotive Boilers.

The Cause of Foaming in Locomotive Boilers. C. Herschel Koyl. Explains many causes of boiler foaming. 2000 w. R R Gaz—Oct. 12, 1900. No. 37091.

Locomotives.

Acceptance Tests for Locomotives. Communications considering the advantages of such tests. Also editorial. 2900 w. R R Gaz—Oct. 10, 1900. No. 37184.

A Locomotive with "Helping Cylinders" at the Paris Exposition. Illustrates and describes a novel engine exhibited by a Munich firm. 800 w. Eng News—Oct. 4, 1900. No. 37005.

Compounds and Light Loads. Editorial discussion of the operation of compounds with light loads, and suggestions for mak-

ing the engines better adapted for all kinds of service. 600 w. Loc Engng—Oct., 1900. No. 36913 C.

Compound Express Locomotive (Locomotive Compound à Grande Vitesse). F. Barbier. A detailed examination of the powerful two-cylinder compound locomotive of the Hungarian State Railways, exhibited at Paris. 2000 w. 1 plate. Génie Civil—Oct. 6, 1900. No. 37307 D.

Design for Mogul Locomotive with Wide Fire Box. D. R. Sweney. Presents plan of engine as an attempt to supply a larger grate with as few experimental details as possible. 1000 w. Am Engr & R R Jour—Oct., 1900. No. 36900 C.

Express Locomotive with Superheater. Illustrates and describes a German locomotive at the Paris Exhibition, with a superheater arranged in the smoke box. It is intended to secure superheated steam for the cylinders, and is claimed to be an economical engine. 700 w. Loc Engng—Oct., 1900. No. 36916 C.

High-Speed Locomotive (Thuile System). Illustrated description of an exhibit of Messrs. Schneider & Co., at Paris, designed to haul trains of 100 to 200 tons, at a speed of 75 miles per hour on a level gradient. 600 w. Engng—Sept. 28, 1900. No. 37029 A.

Locomotive for the Eastern Railway of China (Locomotive des Chemins de Fer de l'Est Chinois). Illustrated description of two-cylinder compound engine built by the Fives-Lille Company for the Manchurian section of the Siberian Railway. 1000 w. Génie Civil—Sept. 15, 1900. No. 37303 D.

Locomotive Saloon for the London & South-Western Railway. Illustrated description of a novel inspection engine, combining a locomotive and saloon. 500 w. Engr, Lond—Sept. 28, 1900. No. 37026 A.

"Northwestern Type" Passenger Locomotive. Comparison with standard passenger engines on the N. Y. C. & H. R. R. R. Ill. 1800 w. Am Engr & R R Jour—Oct., 1900. No. 36896 C.

Road Tests of Locomotives. Gaetano Lanza. How to obtain the objects sought in making tests, the methods used, and matters important in securing accuracy. General discussion. 10500 w. Cent Ry Club—Sept., 1900. No. 37066 C.

The Efficiency of Modern High-Speed Locomotives (Die Leistungen Moderner Schnellzuglocomotiven). Rolf Sanzin. With diagrams of efficiency curves plotted from actual results with various engines and trains. 6000 w. Zeitschr d Oesterr Ing u Arch Ver—Sept. 28, 1900. No. 37318 B.

The Phleger Locomotive. C. H. Caruthers. Historical article describing this type as supplied to the Pennsylvania R. R. from 1853 to 1860. 2000 w. Loc Engng—Oct., 1900. No. 36915 C.

The Thuile Express Locomotive (Locomotive à Grande Vitesse Système Thuile). L. Prevost. Illustrated description of powerful French express locomotive designed to make a speed of 75 miles per hour. 2500 w. 2 plates. Mem Soc Ing Civ de France—Sept., 1900. No. 37344 G.

Twelve-Wheel Wide Fire-Box Freight Locomotive—Buffalo, Rochester & Pittsburg Ry. Illustrations, dimensions and brief description. 600 w. R R Gaz—Oct. 12, 1900. No. 37093.

What One of the Large Locomotives Is Doing. Showing what is being done by a large engine and demonstrating the economy of large engines where there is load enough to warrant their use. 300 w. Ill. Loc Engng—Oct., 1900. No. 36914 C.

Wide Fireboxes and Large Driving Wheels. F. F. Gaines. Illustrates and describes a new design for passenger service on the Lehigh Valley Railroad. 1400 w. Am Engr & R R Jour—Oct., 1900. No. 36898 C.

Railway Wagons.

Failures in the Draw and Buffing Gear of Railway Wagons. George Tertius Glover. Contributed to the Inst. of Civ. Engs., England. Describes the arrangement of the gear often used, the causes of failure, methods of coupling, etc., in this article. Ill. 2000 w. Col Guard—Oct. 19, 1900. Serial. 1st part. No. 37-278 A.

Resistance.

Train Resistances. Lester Daniel. Some results, obtained by tests, and investigations and formulas. 1500 w. Engs' Year Bk., 1900—Univ of Minn. No. 36-967 E.

Measurement of the Tractive Force, Resistance and Acceleration of Trains. A. Mallock. Read before the British Assn. Short account of experiments recently made on electric and other railways. Ill. 1800 w. Engr, Lond—Sept. 28, 1900. No. 37028 A.

Snow Plow.

Snow Plow, Vermont Valley R. R. Illustrated description. 800 w. Ry & Engng Rev—Oct. 6, 1900. No. 37057.

Truck Frames.

The Stresses in Arch Bar Frames. George I. King. Results of investigations of the stresses developed in arch bars for diamond frame trucks. Ill. 3500 w. R R Gaz—Oct. 5, 1900. No. 37011.

Valve Gear.

Valve Gear for Four-Cylinder Compound Locomotives (Steuerung für Verbund-Lokomotiven mit Vier Dampfcylindern). A description of the Von Borries system, in which a single modified Walschaert gear serves for each pair

of cylinders. 800 w. Glaser's Annalen—Oct. 1, 1900. No. 37339 D.

PERMANENT WAY AND FIXTURES.

Dirt Handling.

A Record in Dirt Handling. Illustrates and describes methods used in widening banks and ballasting on the Kansas City Southern Railway, and of the appliances used. 4500 w. Ry Age—Oct. 12, 1900. No. 37152.

Mountain Railways.

A New Form of Rack Rail for Mountain Railways. Illustrated description of the form devised by Emil Strub for the Jungfrau Ry. 600 w. Eng News—Oct. 11, 1900. No. 37109.

Rails.

Recent Practice in Rails. Abstract of the discussion on rails at the London meeting of the Am. Soc. of Civ. Engs. 2200 w. R R Gaz—Oct. 12, 1900. No. 37092.

Round Houses.

Round-House Construction. A discussion, containing communications from Thomas Appleton, W. H. Marshall, and others. 2500 w. Cent Ry Club—Sept., 1900. No. 37067 C.

Shops.

New Shops of the Hannibal & St. Joseph Railroad. Plans and description. 600 w. R R Gaz—Oct. 5, 1900. No. 37009.

Sleepers.

Steel Sleepers (Les Traverses d'Acier). An account of the experiences with steel railway-sleepers on the State Railway of Sumatra. 3500 w. Revue Technique—Sept. 25, 1900. No. 37314 D.

Tunnels.

See Civil Engineering, Construction.

Viaduct.

See Civil Engineering, Bridges.

STREET AND ELECTRIC TRAMWAYS

Berlin.

The Berlin Electric Elevated Road. An illustrated description of the latest practice in Germany in this branch of engineering. 4000 w. St Ry Jour—Oct. 13, 1900. No. 37088 D.

Carlisle, England.

The Electric Tramway System of Carlisle, England. Illustrates and describes a typical British installation. 1300 w. St Ry Jour—Oct. 13, 1900. No. 37089 D.

Comparison.

A Three-Year Comparison of Cable, Electric, and Horse Traction in New York City. 2500 w. St Ry Jour—Oct. 13, 1900. No. 37090 D.

Current Consumption.

The Average Consumption of Current in Electric Tramways (Der Mittlere Stromverbrauch von Elektrischen Strassenbahnen). K. Sieber. Developing a formula for practical use, and examples of its application. 3000 w. Elektrotech Zeitschr—Oct. 4, 1900. No. 37356 B.

Curves.

Connecting Curves on Electric Tramways (Uebergangskurven bei Elektrischen Strassenbahnen). K. Sieber. An examination of the resistance offered by curves on tramways, with reference to the consequent consumption of electric power. 1800 w. Elektrotech Zeitschr—Oct. 18, 1900. No. 37363 B.

Demerbe System.

Recent Tramway Construction: With Special Reference to the Demerbe System. William Dawson. Read at Bradford meeting of the Brit. Assn. for the Adv. of Science. An illustrated description of the system named, with brief notes on other systems. 2500 w. Elec Rev, Lond—Sept. 28, 1900. No. 37015 A.

Electric Locomotive.

The Paris Exhibition—Electric Locomotive. Illustrated description of an electric locomotive intended for working a rack railway, as well as on smooth rails. 900 w. Engr, Lond—Sept. 28, 1900. No. 37027 A.

The Standard-Gauge Electric Locomotive Exhibited by the Allgemeine Elektricitäts-Gesellschaft at the Paris Exhibition. Illustrated description of a locomotive designed for the haulage on branch lines and for shunting purposes. 2000 w. Elec Engr, Lond—Sept. 28, 1900. No. 37123 A.

Electric Motor.

The Electric Railway Motor. John Lundie. Sketches the duty required of an electric motor applied to railway traction, and discusses the method of rating the horse-power. 4200 w. St Ry Jour—Oct. 13, 1900. No. 37082 D.

Exposition.

Electric Transport at the Exposition (Les Transports Electriques de l'Exposition). Alfred Boudon. A very full account of the traveling platform and the electric railway at the Paris Exposition. Two articles, 1 plate. 5000 w. Génie Civil—Sept. 15, 22, 1900. No. 37301 each D.

France.

Electric Railway Practice in France. A. N. Connett. An illustrated account of the methods employed, the attention given

to tasteful construction in overhead work, and the general progress. 9500 w. St Ry Jour—Oct. 13, 1900. No. 37080 D.

Guard Wires.

See Electrical Engineering, Distribution.

Italian Railway.

Electric Traction on a Main Line Italian Railway. Enrico Bignami. Illustrates and describes the electrical equipment of the Lecco, Sondrio and Chiavenna line in the north of Italy, with a three-phase traction system, using induction motors on the cars. 2000 w. Elec Rev, N. Y.—Oct. 10, 1900. No. 37149.

Kansas City.

Pioneer Electric Railway Work in Kansas City. John C. Henry. Brief history of the early electric railroads. 2300 w. Elec Wld & Engr—Sept. 29, 1900. No. 36901.

The Street Railway Situation in the Two Kansas Cities. Illustrated description of this example of the best American practice. 6500 w. St Ry Jour—Oct. 13, 1900. No. 37079 D.

Limoges.

The Tramways of Limoges (Les Tramways de Limoges). M. Delage. A detailed account of the Limoges tramway system, giving details of construction, operation, and maintenance. 12000 w. 4 plates. Ann des Ponts et Chaussées—2 Trimestre, 1900. No. 37326 E + F.

Polyphase.

Polyphase Railway Apparatus and Methods. Louis Bell. Treats of the latest American practice in polyphase distribution, and the use of polyphase motors for railway work. Ill. 4200 w. St Ry Jour—Oct. 13, 1900. No. 37086 D.

The Burgdorf-Thun Polyphase Electric Railway. W. Rung. Translated from the Danish paper *Ingenioren*. A statement of the advantages of alternating current for railway working, and an illustrated description of the new railway from Burgdorf to Thun. 1500 w. Elec Rev, Lond—Oct. 12, 1900. Serial. 1st part. No. 37207 A.

Power Station.

A Water-Power Railway Plant. W. N. Zurfluh. Illustrates and describes the power house of the Toledo & Maumee Valley Traction Company. 1300 w. Am Elect'n—Oct., 1900. No. 37062.

The Ninety-Sixth Street Power Station of the Metropolitan Street Railway Company, of New York City. Discussion of paper by L. G. Montony. 1700 w. Pro Am Soc of Civ Engs—Oct., 1900. No. 37261 E.

The Traction Power Plant of the Paris Exposition. Illustrated description of the sub-station on the Quai d'Orsay. 1200 w. Elec Wld & Engr—Oct. 20, 1900. No. 37213.

Resistance.

The Resistance of Iron Conductors to Alternating Currents (Ueber den Widerstand Eiserner Wechselstromleiter). C. Feldmann and J. Herzog. A mathematical investigation, with practical applications to the use of rails as return conductors in tramways. 3000 w. Elektrotech Zeitschr—Oct. 11, 1900. No. 37359 B.

Rolling Stock.

Cars and Car Service in Metropolitan New York. H. H. Vreeland. A review of experiences since 1893, the traffic conditions, and methods adopted. 3200 w. St Ry Jour—Oct. 13, 1900. No. 37083 D.

The Standard Cars of the Metropolitan Street Railway Company of New York. Thomas Millen. Illustrates and describes in detail the four standards used by the company, and devices that have been found convenient. 3400 w. St Ry Jour—Oct. 13, 1900. No. 37084 D.

Speed.

Speed on the London Undergrounds. Illustrates and describes the methods used on the Central London Ry., and gives tabulated records of time on this road and also on the District Ry., and the City and South London Ry. 1700 w. Elec Engr, Lond—Oct. 5, 1900. No. 37126 A.

Storage Batteries.

Storage Batteries in Electric Railway Power Stations. Edward L. Reynolds. Cites results now being obtained in the operation of several railways, thus showing the advantages. 1300 w. Am Elect'n—Oct., 1900. No. 37064.

Suspended Road.

The Barmen-Elberfeld-Vohwinkel Suspended Railway (Die Schwebebahn Barmen-Elberfeld-Vohwinkel). A very complete and fully illustrated account of this successful overhead electric railway, with details of construction. 15000 w. Zeitschr d Ver Deutscher Ing—Oct. 13, 1900. No. 37331 D.

Third-Rail.

The Electrical Equipment of the Albany & Hudson Railway and Power Company. Illustrates and describes some features of the electrical equipment of the longest and most important third-rail electric system in the world. 1200 w. Elec Rev, N. Y.—Oct. 17, 1900. No. 37181.

Underground.

Results of Experience with the Boston subway (Erfolge und Erfahrungen mit der Bostoner Unterpflasterbahn). Fritz v. Emperger. An examination of the Boston subway, with especial reference to underground railways in other cities. 5000 w. Zeitschr d Oesterr Ing u Arch Ver—Oct. 5, 1900. No. 37320 B.

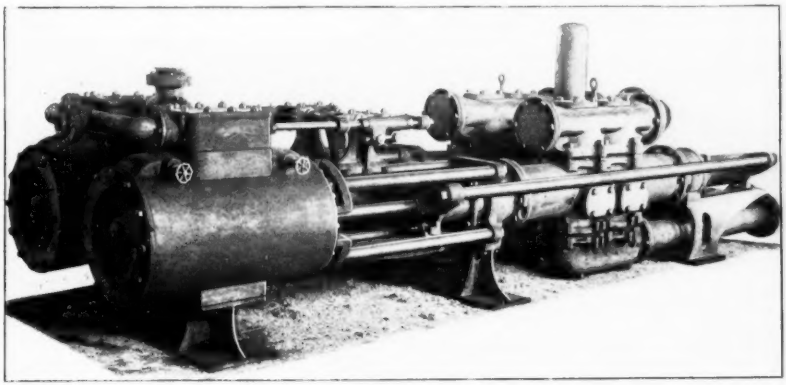
IMPROVED MACHINERY

New Processes and New Appliances

The matter here published is not paid for, nor can it be classed as advertising. But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

The Straitway Pump.

THE type of pump illustrated on this page has certain novel features of interest to those who use pumping machinery. The Straightway hanging suction chamber permits of a low, narrow construction, with direct water ways. This chamber, when in place, is at such a distance from the floor or foundation that when its bolts are loosened it falls sufficiently to permit being pulled out of the way. One man can make this change on 12-inch water ends in less than an hour's time. These water ends permit of lead lining, which makes a most serviceable pump for bad water, especially for mining in regions where the water is surcharged with acids destructive to iron.



Full information will be furnished by the builders, Scranton Steam Pump Co., Scranton, Pa., upon request.

Triumph Enclosed Motors.

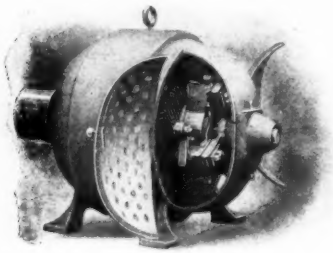
THE two small cuts herewith represent the Triumph Electric Company's enclosed motor, open and closed. These motors are designed especially for use in exceptionally dirty or dusty localities where there is considerable dust of an inflammable character, or for use in damp places, gaskets being provided on the doors to prevent moisture from getting into the motor. They are also especially adapted for use in machine shops and places where there would be any flying particles, for the doors protect them from mechanical injury. These are perforated or cast solid, just as preferred. When perforated, a screen of very small mesh is placed in the door over these perforations, thus preventing anything from getting into the motor, but still allowing for a free circulation of air.

The end plates carrying the doors and the bearings are bored accurately with a jig so that they can be turned around to any position desired, and consequently make a machine either for the floor, wall or ceiling. These motors are made of slow and moderate speed types, and are made at present in sizes from one to thirty horse power. Quite often this type of motor is direct-connected to a machine-tool, either by means of a coupling or through gearing. As it is thoroughly protected it is consequently very applicable to direct connection.

The doors of these motors are so arranged as to be readily taken off, so that

they can be used as an entirely open type motor, semi-enclosed or entirely enclosed.

There are laminated pole pieces, each disk being specially treated before being put together, thus preventing eddy currents. The pole pieces are of the laminated type, cast-welded into the frame; the armature is of the ironclad, laminated-core type, each lamination in the armature being especially treated



to reduce eddy currents and increase the efficiency.

The armature coils, as well as the coils of the field windings, are bound, insulated and tested before being placed in position in the machine. All coils are machine wound and interchangeable and can be easily removed and replaced. The brushes are of carbon,

and the boxes of the self-oiling self-aligning type. Every part of the motor is made to a gauge and any part can be easily duplicated.

These motors are furnished shunt, compound and series wound, according to the requirements. When shunt and compound wound they are supplied with a starting box or speed controller, as is desired. When series wound for use on cranes or hoists or any work of this character, where the motor is required reversible to operate at different speeds, they are supplied with series reversing controllers.

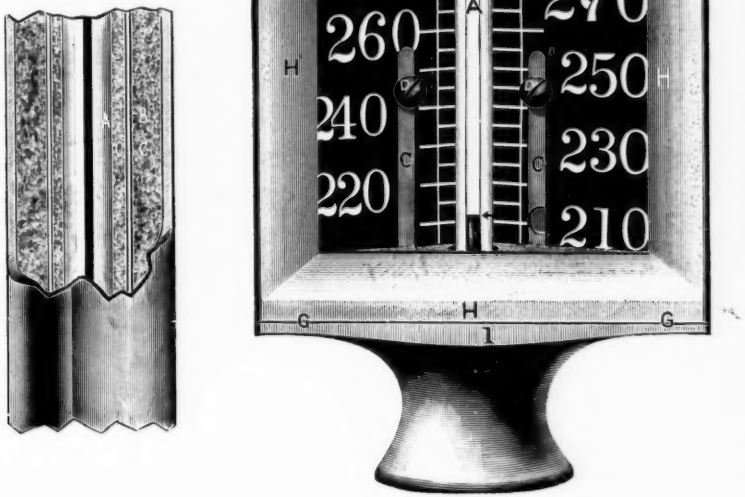
Further details may be had from the Triumph Electric Company, Cincinnati, O.

Mercurial Pyrometers.

EVERY engineer recognizes as a means to economy in fuel consumption the importance of determining the temperature of escaping gases in the stack. The liability to derangement of mechanical pyrometers has led to the perfection of a mercurial pyrometer, so constructed as to give accurate indications up to 950° Fahrenheit. The illustration shows the instrument referred to, the construction of which is as follows:

The glass from which the thermometer tube is made is a product of the Jena Glass Works, Germany, and its peculiarity is its high resistance under pressure. The boiling point of mercury in a vacuum is between 500 and 600 degrees. This is overcome in the mercurial flue gas pyrometer by filling the tube above the mercury column with nitrogen gas under high pressure, and sealing the tube while under pressure; this raises the boiling point of the mercury, and the resistance of the glass is such as to permit of exposure, without damage, to temperatures as high as 1,000° Fahrenheit. The thermometer tube is first encased in a glass shell as

shown in the sectional cut, the space between the thermometer tube and the wall of the glass case being filled with a non-conducting packing, which acts in the double capacity of protecting the tube from breakage, and insulating the stem from exposure to the high temperatures to which its bulb is subjected. The glass casing is then wound with the same insulating material, and the tube, thus encased and insulated, is mounted in a seamless drawn steel tube 1¼ inches in diameter, the bulb of the tube being encased in the small chamber connected to the lower end of the stem, in which chamber it is surrounded by precipitated copper; this acts in the dual capacity of a protection against breakage and a rapid conductor to the bulb of the exposed temperature when in use.



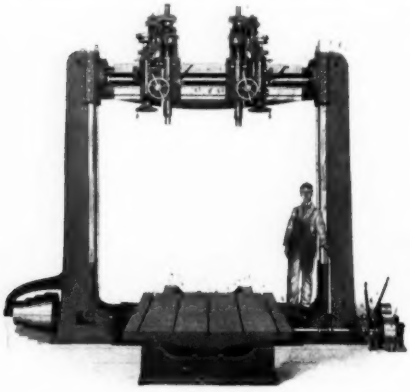
The upper part of the frame or scale case is a triangular shaped aluminum casting in two parts. The section marked *H* is a removable front to which is attached a glass, covering the scales and that portion of the thermometer tube which is exposed. The construction throughout is most substantial, and the instrument can be used either in a horizontal or a vertical position, the pressure of gas in the tube preventing any derangement of the mercury column if used horizontally.

The Hohmann & Maurer Mfg. Co., Rochester, N. Y., publish an interesting pamphlet upon the subject of steam plant thermometers, containing much information upon the subject of flue gas temperatures and other matters interesting to engineers.

Two-Spindle Boring Machine.

We here illustrate a massive vertical two-spindle boring machine, built by the Prentice Brothers Company, of Worcester, Mass. The machine was designed for the Wilson & Snyder Mfg. Company, of Pittsburg, for use in boring the large parts of pumps. It is a very heavy and powerful machine, and will take under the spindles 8 feet and between the housings 10 feet. The table has a traverse of 10 feet upon the bed and is 8 feet wide. The cross rail has a vertical adjustment by power, while the table has a movement along the bed by power, or by a ratchet lever. While the machine would easily drive a twist drill through solid stock up to 4 inches, work of this kind would, of course, not be economi-

cal, since it would be more advantageous in drilling such large holes to first put through a small drill (leading the hole) to prepare the way for the thick point of the large drill. Usually large holes are cored, a machine being used for enlarging them.

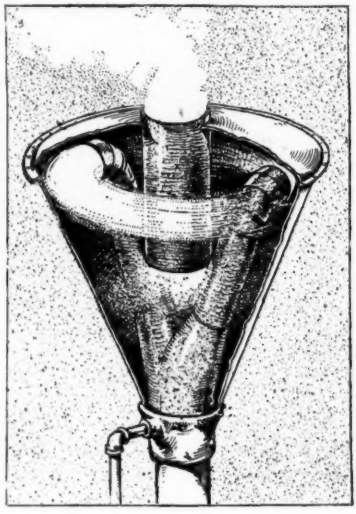


With the common practice of coring holes—namely, calculating on, say, ¼ inch stock to be removed—there is hardly any limit to the capacity of this machine for boring. It is safe to say that it will bore and face valve seats or similar work up to 10 or even 12 inches, and perhaps more. The total weight of the machine is 24 tons.

The Sturtevant Exhaust Head.

An interesting example of the practical application of centrifugal force is presented in the design of the Sturtevant exhaust head. The accompanying illustration serves not only show its construction, but also its method of operation.

Externally it appears to be an inverted cone of heavy galvanized steel plate attached to the end of the exhaust pipe. Its interior construction is shown to consist of two branching pipes extending upward from and connected to the exhaust pipe. These individual pipes, which are parallel to the sides of the casing, terminate in elbows from which the steam escapes. Its contact with the circular sides of the case gives it a whirling motion which thus gives centrifugal force an opportunity to act. Inasmuch as this force is proportional to the weight of the substance acted upon, and as water weighs about 1,600 times as much as exhaust steam, the natural result is that the water contained in the steam is thrown outward in radial lines with great force. Striking upon the sides of the cone it trickles to the bottom and there escapes through the drip pipe. Such oil as may be



entrained with the steam is likewise separated.

The steam, now dry, is forced downward by the additional entering volumes and quietly escapes to the atmosphere through the central pipe. It is evident that all tendency on the part of the water to escape with the steam is most forcibly overcome by the centrifugal action.

The central pipe being made larger than the supply beneath, and the cold sides of the case tending to condense a portion of the steam, it is manifest that no back pressure can be exerted upon the engine. The absence of baffle plates and the absolute simplicity of design are the best guarantees of endurance on the part of this head. It is built by the B. F. Sturtevant Co., of Boston, Mass., in sizes ranging from 1 inch up to 36 inches size of exhaust pipe.

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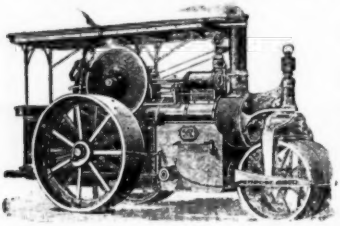

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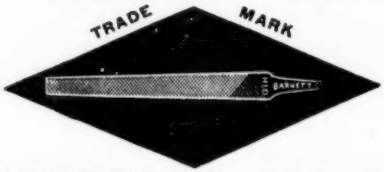

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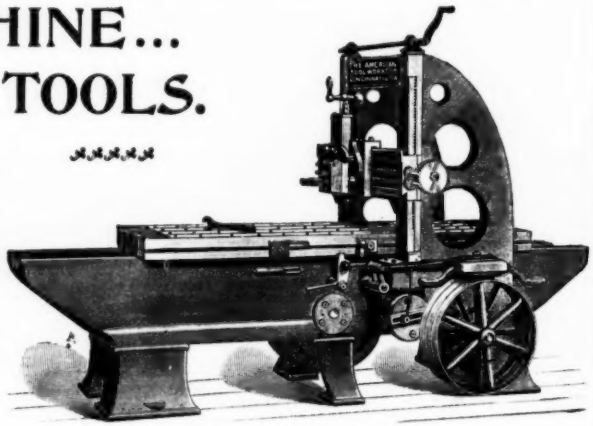

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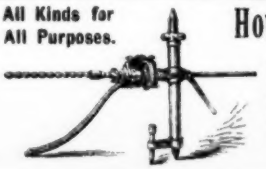

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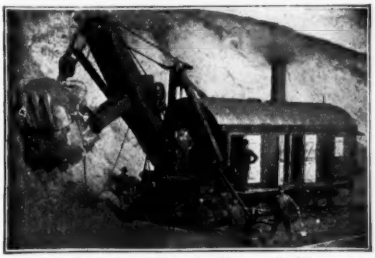

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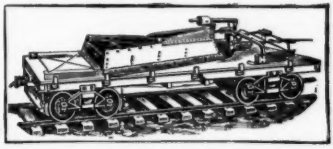

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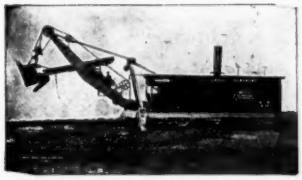

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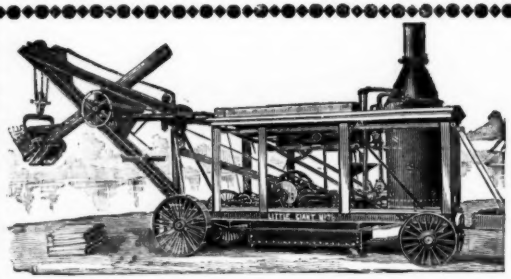

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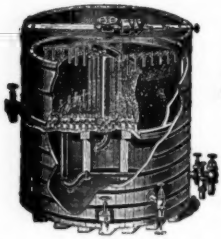

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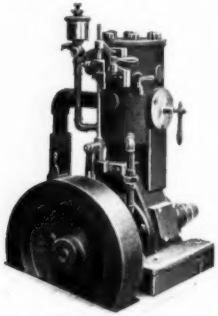

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AUTHORS AND PAPERS FOR JANUARY, 1901.

BENJAMIN TAYLOR (*Lord Armstrong and the Elswick Works*)—A close observer and student of the broad influence of engineering progress and the economic effects of mechanical improvement. He is a contributor to many of the best periodicals, British and American. He is a Fellow of the Royal Geographical Society, a resident of Glasgow, and in close touch with the important engineering undertakings, accomplished or proposed, in Great Britain.

CHARLES M. SCHWAB (*The Huge Enterprises Built Up by Andrew Carnegie*)—Mr. Schwab is a descendant of a German family, for three generations resident of the United States. His father was a woolen manufacturer in Williamsburg, Pa., and here Mr. Schwab was born. He received his scientific education under the Franciscan friars, his earlier boyhood having been spent on the farm and in driving the mail coach from Cresson Station to Loretto. Upon graduation, in 1880, he took a position in a grocery in Braddock, Pa., but after two months found an opening more suited to his taste and ability in the engineering department of the Carnegie Steel Co. His first duty was stake driving with the surveying corps at the Edgar Thomson Steel Works, but in six months he was appointed chief engineer, and while at the head of the engineering department supervised the construction of eight of the nine blast furnaces now comprised in the Edgar Thomson plant—at present the most extensive group of furnaces in the world.

He continued as chief engineer and assistant manager at the Edgar Thomson plant from 1881 to 1887, co-operating with the late Capt. Jones, who was general manager, in the perfection and practical development of the metal mixer—an invention now in universal use, whereby manufacturing cost is greatly reduced and blast furnace workmen are relieved of some of the most exhausting drudgery operatives have ever been called on to perform. In 1887, he was appointed superintendent of the Homestead Steel Works of the Carnegie Steel Co., Ltd., and reconstructed the entire establishment, making it the largest plant in the world of its class. Soon after he assumed the management, the Carnegie Co. undertook the manufacture of armour plate, and the success attending this enterprise from the first is due to his clear perception of the difficulties involved and the manner in which he overcame the obstacles. He remained as superintendent at the Homestead plant until October, 1899, when, upon the death of Captain Jones, he was appointed general superintendent of the Edgar Thomson Steel Works and Edgar Thomson furnaces. In 1892 the Homestead Steel Works were also placed under his management for the second time, directing the operations of both immense plants, employing thousands of men, and producing several million tons of steel per annum. He was elected to the board of managers of the Carnegie Steel Co., Ltd., in 1896; in February, 1897, succeeded the Hon. John G. A. Leishman to the presidency of the Carnegie enterprises; in March, 1900, was elected president of the new corporation named The Carnegie Co., owning and controlling all the mining, manufacturing, and transportation apparatus. He is also president of the Carnegie Steel Co., which conducts the steel-manufacturing operations. Many of the rolling-mill devices and steel-works improvements in use throughout the world are the product of his genius. He is a member of the Institute of Mining Engineers, American Iron and Steel Association, and the British Iron and Steel Institute. He has founded a free polytechnic school for educating boys in mechanical engineering, and is contemplating a training school for girls.

EMIL SCHROEDTER (*The Founders of the Krupp Establishments*)—Born February 26, 1855, in Düsseldorf; studied mechanical engineering and metallurgy at Carlsruhe and Berlin, and then became actively engaged in machine shops and metallargical establishments in the Rhine Provinces and Upper Silesia. On January 1, 1881, he entered into the business management of the Verein deutscher Eisenhüttenleute, and became an editor of *Stahl und Eisen*, their official organ, and in 1885 assumed sole direction of the business of the society.

AUTHORS AND PAPERS FOR JANUARY, 1901.

WALTER M. McFARLAND (*George Westinghouse—Inventor, Organiser, and Director*)—Born in 1859. Educated in public schools of Washington, D. C., and at U. S. Naval Academy, where he graduated as a cadet engineer in 1879. Served on naval vessels in various parts of the world. Was assistant professor of mechanical engineering at Cornell University, by detail from the Navy; secretary of division of marine engineering of International Engineering Congress, 1893; delegate from United States Navy Department to International Congress of Naval Architects and Marine Engineers, 1897. Was twice assistant to Admiral Melville, Engineer-in-Chief, U. S. Navy, the last time as principal assistant. Member of board to reorganise personnel of the United States Navy. Was promoted to grade of chief engineer in 1898. Resigned from the Navy in 1899, to go with the Westinghouse Electric and Manufacturing Company, of which he is acting vice-president.

SIR BENJAMIN C. BROWNE, D. C. L., J. P. (*Standardising in Engineering Construction*)—Born 1839; educated at Westminster and King's College, London; apprenticed as an engineer to Lord Armstrong, Elswick Works, 1856. Chairman of R. & W. Hawthorn, Leslie & Co., engineers and ship-builders, Newcastle-on-Tyne; member of the Institution of Civil Engineers; member of the Institution of Naval Architects; Mayor of Newcastle, 1885-1887. An able writer on social economic questions, and one of the clearest thinkers on existing industrial conditions in England.

GEORGE NICOL BARNES (*The Old Trade-Unionism vs. Wisely Organized Labor*)—Born at Lochee, Scotland, 1859, and apprenticed to the engineering trade at the age of thirteen. At the end of his apprenticeship he went to Barrow, and from there to London. In 1892 he was selected assistant general secretary of the Amalgamated Society of Engineers, giving up that position in 1895 to contest the position of general secretary, to which he was elected in 1896. Mr. Barnes takes an intense interest in all questions affecting the interests of the working classes, and writes and lectures with equal success on such topics as "Co-operation," "Old-Age Pensions," and "The Housing Problems," etc. In 1895 he stood as candidate of the Independent Labor Party for Rochdale in the Parliamentary election, polling 1,251 votes. The reports of his tours in Germany and his prominence in the adjustment of the serious labour questions which have recently perplexed Great Britain have attracted much attention in the engineering trade.

MILTON P. HIGGINS (*Intensified Production and Its Influence Upon the Worker*)—Born in the State of Maine and brought up on a farm, attending district schools and academies until he was seventeen years of age; left school to learn machinists' trade, and early engaged in designing machinery and in contract work at machine building. After mastering his trade at twenty-two years of age, he entered the scientific department of Dartmouth College, for which he had prepared himself by night study. Upon his graduation, in 1868, he was at once called to take charge of the Washburn shops of the Worcester Polytechnic Institute, where he remained for twenty-eight years. The institution owes no small share of its practical success and high reputation to his untiring zeal, ability, and devotion to the cause of practical education. Professor Higgins is recognised as an authority on technical education. He is, moreover, a practical manufacturer, president of the Norton Emery Wheel Co., the Plunger Elevator Co., and the Norton Grinding Co., all of which he has conducted with great success. He is still actively interested in industrial and technical education, and is recognised as a leading authority upon the tendencies of modern practice in the engineering industries.

JOHN HENRY PATTERSON (*Altruism and Sympathy as Factors in Works Administration*)—Born near Dayton, Ohio, 1844, of a family noted in the pioneer history of Kentucky and Ohio; spent his boyhood on the farm, and attended district schools; at eighteen entered Miami College, remaining there three years and taking his senior year at Dartmouth College, from which he graduated in 1867. After spending three years as collector of tolls on the Miami Canal, and in the retail coal trade, he became interested in coal mining in Jackson County, Ohio, 1878, and was later associated in building the Dayton and South Eastern Railway. In 1880 he became general manager for the Southern Ohio Coal and Iron Co., with offices at Dayton, Ohio. In 1882, with his brother, Frank J. Patterson, he became interested in the manufacture of cash registers. The great development of this business is directly due to the energy and diligence of the two brothers. The National Manufacturing Co., of which he became a director, was organised in the same year. In 1885 this company was reorganised under its present name, the National Cash Register Co., Mr. Patterson becoming its president and manager. The capital stock was increased to $100,000, in 1886, to $500,000, in 1891, and to $5,000,000 in 1899. Its factory now covers more than fourteen acres of floor space. It employs more than 2,200 men and 300 women, with a sale force and office forces distributed over the world of 400 each.

Mr. Patterson is widely known as an advocate of co-operation between employer and employee, and has spoken and written forcibly upon social and economic problems, labour questions, and legislative reform. He carries his ideas into active practice in his own company.

FREDERIC REMSEN HUTTON (*Relation of the Steam Engine to Modern Economic Production*)—Professor of Mechanical Engineering at Columbia University, New York, and Dean of the School of Mines of the same institution; also secretary of the American Society of Mechanical Engineers since 1883. Author of a treatise on the Mechanical Engineering of Power Plants, and of a text book on Heat Motors. Professor Hutton is well and widely known as an authority on the application of motive power to mechanical industries, both from its historical side and in its practical applications.

AUTHORS AND PAPERS FOR JANUARY, 1901.

SANFORD E. THOMPSON (*The Intensified Piece-Rate System in Practice*)—Born Ogdensburg, N. Y., 1867; graduated from the Massachusetts Institute of Technology, 1889; immediately after graduating went to Solon, Me., in the employ of the Moosehead Pulp and Paper Co., in charge of all civil engineering, construction, and estimates. Upon completion of this plant, associated himself with the Manufacturing Investment Co., looking after work in Michigan, Wisconsin and Maine. During this period and since leaving this company, in 1892, he has been engaged in the design and construction of water-power plants and mills, in superintending the erection of such installations, in mill management, and in systematising industrial organisation. During part of this time he has been connected with Mr. Fred. W. Taylor, consulting engineer of the Bethlehem Steel Co., at South Bethlehem, Pa. He is inventor of special apparatus for taking time records of men and machinery.

HENRY McCOY NORRIS (*The Premium Plan of Labour Remuneration*)—Born in Trenton, N. J., 1868; was apprenticed to Bement, Miles & Co., Philadelphia, Pa.; took special course in mechanical engineering at Sibley College, Cornell University; was draughtsman with the Phœnix Iron Co., Phœnixville, Pa., John A. Roebling & Son's Co., Trenton, N. J., the Brown & Sharpe Mfg. Co., Providence, R. I., and other concerns; designer with A. H. Reid, Philadelphia, Pa., and the Pond Machine-Tool Co., Plainfield, N. J.; superintendent of the Appleton Mfg. Co., Philadelphia, Pa., and the Riehlé Bros. Testing-Machine Co., Philadelphia, Pa.; engineer with the Garvin Machine Co., New York; general manager of the Campbell & Zell Co., Baltimore, Md., and superintendent, engineer and manager of the Bickford Drill & Tool Co., Cincinnati, Ohio. Mr. Norris is a member of the American Society of Mechanical Engineers and other societies.

PERCY LONGMUIR (*A Survey of Advanced Foundry Practice*)—Served an apprenticeship in Sheffield to steel, iron, and brass founding; trained as a metallurgist in the laboratories of the Sheffield University College; possesses a wide experience of Scotch and English methods of foundry practice, and an earnest student of American and Continental methods. A member of the American Foundrymen's Association, and contributor to the American *Foundry;* a member of the Sheffield Society of Engineers and Metallurgists.

JOHN E. HARDMAN (*The Practical Management of Mining Operation*)—Born in Lowell, Mass., 1856; graduated from the Massachusetts Institute of Technology in 1877 as mining engineer, with degree of S. B.; afterwards studied a short time in England and Germany; went to Leadville in 1878; built the first smelting works at Red Cliff (now Eagle City); was on the staff of the U. S. Geological Survey in 1880; has had practical experience in gold, silver, copper, lead, and antimony mines, in Georgia, North Carolina, Nova Scotia, Colorado, Montana, Ontario, and British Columbia; was professor of mining and metallurgy at McGill University, 1895-96, resigning to act as consulting mining engineer for Canadian and English companies operating in Canada and the United States. Is a member of the American Institute of Mining Engineers, the North of England Institute of Mining and Mechanical Engineers, is a past president of the Nova Scotia Mining Society, and of the Canadian Mining Institute; holds the honorary degrees of B. Ap. Sc. and Ma. E.

A. G. CHARLETON (*Principles and Methods for Profitably Working the Mine*)—A mining engineer of more than twenty years' practical experience in mining, concentration, amalgamation, and smelting of ores, designing and erecting stamp mills, concentration works and other machinery; also in the financial administration and executive management of companies in various parts of the world. Has inspected and reported upon mining properties and mines of gold, silver, and less precious metals in Great Britain, Saxony, the Harz, Canada, India, the United States, Queensland, and Bohemia; has been engaged with manufacturers of mining machinery in New York, and has filled positions as assayer and surveyor; since 1895 has been established as consulting engineer in London, serving in this capacity for the Exploration and Gold Mining Association, Ltd., the Prospectors of Matabeleland, South Africa, and other concerns; author of several books and many contributions to the technical press upon mining problems; graduate of Frieberg; a member of the Institution of Mining Engineers and of the council of this institution; vice-president of the Institution of Mining and Metallurgy; member of the American Institute of Mining Engineers, A. R. M. S., etc.

JAMES NEWTON GUNN (*Cost Keeping: A Subject of Fundamental Importance*)—Born Springfield, Ohio, 1867; after graduating from high school, studied chemistry, mining engineering, and surveying; while in the service of the Foos Mfg. Co. first conceived the necessity of studying factory organisation and cost statistics as a science, from an engineering rather than an accounting standpoint. Entered the employ of the Library Bureau, Boston, developing the card-index system in its commercial uses. For six years has devoted himself to installation of modern systems of factory organisation and cost recording. Lecturer, Mass. Inst. of Technology.

J. SLATER LEWIS (*The Commercial and Mechanical Limits of Specialisation*)—Born at the Rake House, Helsby, in 1852, and educated at Nantwick and the Mechanics' Institute, Manchester. He was the founder and engineer and managing director of the Telegraph Manufacturing Company, Limited; subsequently engaged with Messrs. W. T. Goolden & Co.; in 1894 was appointed engineer and general manager to the firm of Messrs. P. R. Jackson & Co., Limited., with which firm he is at the present time engaged. Mr. Slater Lewis is the inventor and patentee of many mechanical and electrical appliances, and the author of a treatise entitled "The Commercial Organisation of Factories." He is a Fellow of the Royal Society of Edinburgh, an associate member of the Institution of Civil Engineers, a member of the Institution of Electrical Engineers, of the Institution of Mechanical Engineers, of the Iron and Steel Institute, and of the Northern Society of Electrical Engineers.

AUTHORS AND PAPERS FOR JANUARY, 1901.

H. F. L. ORCUTT (*Shop Arrangement as a Factor in Efficiency*)—Born in Ellsworth, Me., 1861; after graduation from the high school, in 1879, he entered the employment of F. H. Richards. He went to London for the Pratt & Whitney Company, and for two years acted as their expert on a special machine. For more than eight years his time has been divided between London and Berlin, in close touch with both the commercial and mechanical side of the vast business of Ludwig Loewe & Company. The recent erection of their enormous new works, for which he has been expert mechanical adviser, has been the means of renewing his touch with the latest practice on both sides of the Atlantic, and of crystallising his conclusions as to equipment, organisation and management. His papers on "Machine-Shop Management in Europe and America," published in THE ENGINEERING MAGAZINE in 1899, have become a classic in the newly forming literature of Industrial Engineering.

LOUIS BELL—Graduated from Dartmouth College, 1884, and took the degree of Ph. D. at Johns Hopkins University, 1888; professor of Physics and Applied Electricity at Purdue University, Lafayette, Ind., 1888-89; consulting engineer, Chicago (firm of Bliss & Bell), 1889; editor of *The Electrical World*, N. Y., 1890-91; member A. I. E. E., 1890; engineer in charge of power-transmission work of the General Electric Co., 1892-95; at present consulting engineer, Newton Center, Mass., making a specialty of power transmission and heavy electric-railway work. Dr. Bell's wide range of experience in all fields of electric practice enables him to discuss his topic with matchless authority.

H. F. J. PORTER (*The Radical Policy of Scrapping Costly Machinery*)—Born New York City, 1858; graduated with degree of M. E. from Lehigh University, 1878; took up shop work in the drafting office of the Delamater Iron Works, N. Y., 1878-1882; assistant engineer, New Jersey Steel & Iron Co., Trenton, N. J., 1882-1884; engineer and superintendent, Columbia College, 1884-1890; assistant mechanical engineer, World's Columbian Exposition, Chicago, 1890-1892; assistant chief, machinery department, Exposition, Chicago, 1892-1894; western sales agent at Chicago and assistant sales agent, Bethlehem Steel Works, South Bethlehem, 1894-1900.

W. H. CANNIFF (*The Discipline and Control of Railway Employees*)—Born October 22, 1847, at Litchfield, Mich.; entered railway service in 1863, since which time he has continuously held various positions in connection with railways in all branches of the service up to and including his appointment as general superintendent of the Lake Shore & Michigan Railway Co., January 1, 1892, which position he held when this paper was first written. He is now president of the New York, Chicago & St. Louis Railway.

THE ENGINEERING INDEX.

THE feature of THE ENGINEERING MAGAZINE which distinguishes it from any other publication in the world is its Review and Index to the entire range of current literature.

This presents, first, a forceful review of the most important articles which have appeared during the month in every part of Great Britain, the Colonies, the Continent and the United States; second, a brief abstract of *every* leading technical article printed *anywhere* during the month; and, third, we supply, at a trifle of cost, the full text of every article thus indexed. This body of literature no man who has to plan or buy for any engineering work can afford to ignore—nor attempt to master by any other means than by this service.

The leading articles make THE ENGINEERING MAGAZINE invaluable. The Review and Index of the World's Engineering Press make it indispensable.

THE ENGINEERING INDEX.

Prospectus 1901

THE ENGINEERING MAGAZINE

"THE WORLD IS ITS FIELD."

A Partial List of Important Publications Early Months of 1901

The Industrial Future of Russia

By A. H. FORD.

ON THE WHARF, VLADIVOSTOK. LANDING AMERICAN RAILS FROM A STEAMER.

I. Openings for Industrial Enterprise in the Russian Empire.
II. Engineering Opportunities in Central and Southeastern Asia.
III. The Mechanical Development of Russia.
IV. Russia's System of Trans-Asiatic Waterways.

RUSSIA has been compared to the United States as they were early in the nineteenth century. In vastness of territory to be opened, in demand for means of transport and communication, in measureless need of the tools and machinery of industry, in vast wealth of natural resources awaiting exploitation, in untrained energy of imperfect civilization, Russia parallels early America.

But just at her ports and frontiers stands now, ready to hand, the fully perfected system and equipment which America had not at the start. Russia needs only to apply what the United States had to help largely to create. Her expansion as an industrial nation promises, therefore, a swiftness unequalled by anything preceding. Opportunity and means are both already existent; they need only to be brought together.

For engineers and makers of engineering appliances of every sort, Russia has an interest approached only by the Far East. Accurate information has been curiously scanty. Mr. Ford has had singular facilities for studying Russian affairs, particularly her economic, commercial, and industrial conditions and requirements. His familiarity with the country extends from St. Petersburg to Port Arthur; his information is substantially official. With their many fine illustrations, his articles will form a feature of the utmost interest in THE ENGINEERING MAGAZINE for the first half of 1901.

A German View of American Machine Shops

By PETER LUEDERS.

HERR LUEDERS recently completed an official inspection of American industrial establishments. He now takes up the theme which Mr. Orcutt treated with so much interest in THE ENGINEERING MAGAZINE for 1899, and examines American practice critically, throughout every department of the shop, with the practicality of an experienced manager, the zeal of an apostle of advanced methods, and the discrimination of a critic of cosmopolitan experience. His articles will form a most valuable and interesting counterpart to Mr. Orcutt's widely-read series.

Practice in British Engineering Works

By A. LAZENBY.

AN account of the Willans & Robinson works at Rugby. This is the crack modern English shop, having been planned as a whole and executed with great care. Modern tools and methods are employed throughout, and it was selected as the establishment to exhibit to the American Society of Mechanical Engineers at their recent visit. Mr. Lazenby is the managing director of the Company.

Equipment and Methods of the Indian Dock-Yards

By A. C. BOWDEN.

DESCRIPTIVE accounts of the dockyards at Bombay and Calcutta—their mechanical features, general arrangement, particular conditions, and value to marine, and especially to military and naval interests. With many illustrations of novel and interesting features of the work of the yards. The writer is an executive official and has a thorough and intimate knowledge of his subject.

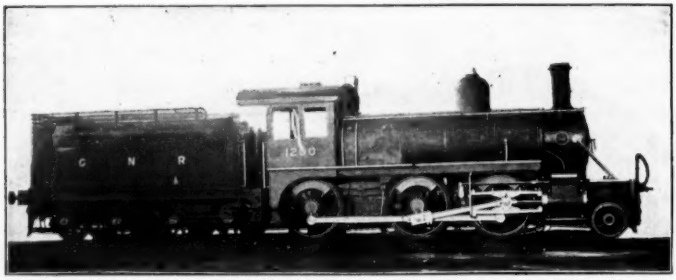
The Dangers of Excessive Standardization of Engineering Methods

By PROF. W. CAWTHORNE UNWIN.

A DISCUSSION of the present tendency to reduce engineering methods to standard codes and systems, making the appearance of system and precision deceptive as to real accuracy and reliability. Standard methods are considered as a means to an end and not as the end itself.

The Performance of American Locomotives in England

By C. ROUS-MARTEN.



GREAT NORTHERN NO. 1200, BUILT BY BURNHAM, WILLIAMS & CO., AT THE BALDWIN WORKS, PHILADELPHIA, U. S. A

INTEREST in the introduction of American engines on British railways in the summer of 1899—The Baldwin and Schenectady locomotives on the Midland and Great Northern railways—Relative questions of boiler and cylinder proportions and steam pressures —The results of a year's experience—Hauling capacity versus fuel consumption—The question of finish and wear-and-tear—What is the "life" of a locomotive?—Practical questions answered in the light of a year's actual experience.

The Cost and Value of High-Speed Trains

By C. ROUS-MARTEN.

THE admitted desirability of high-speed—Fallacious arguments as to the rate of increase in cost—The commercial value of fast trains—Railways which give frequent and regular high-speed service are operated by dividend-paying companies—The elements of cost and their relation to commercial value in railway management—The argument for high speed clearly stated by a trained expert and keen observer.

Railway Development of the Transvaal

By A. COOPER KEY.

A PRACTICAL study of the work to be taken up immediately upon restoration of quiet in South Africa—Existing systems, their traffic and their requirements—Improvements in permanent way and equipment—New lines to be opened—Engineering, commercial, and financial requirements—Relation to the general system of African railways—Opportunities in the engineering field

English and American Steam-Engine Practice

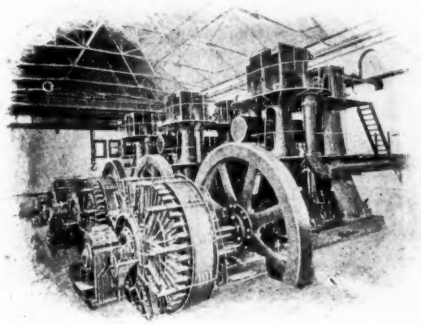
By PHILIP DAWSON.

IMPORTANT and increasing exports of American engines for European installations show the rapid spread of international competition. Some hold that the American engine, like the machine tool, is a formidable factor in European competition; others, that the movement is temporary—due wholly to overcrowding of European shops.

The question is important to both European and American makers and users. It will be thoroughly worked out in Mr. Dawson's richly illustrated articles. His long experience on both sides of the Atlantic will fill them with value and interest.

Steam Engineering Practice in Germany

By M. F. GUTERMUTH.



PROF. GUTERMUTH, who is at present associated with the Polytechnic schools at Darmstadt, has been closely familiar with the rapid progress in Continental steam practice. According to many critics, neither England nor America has kept the pace in this field of engineering which has been set by Germany. Peculiar interest, therefore, will attach to this illustrated exposition of the leading characteristics of German steam engineering and of the installations embodying them.

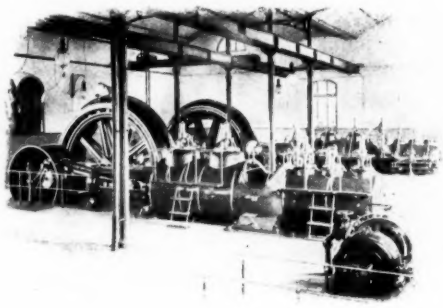
Laboratory Studies of Steam-Engine Performance

By PROF. BOULVIN.

A LEADING specialist in thermodynamics, highly esteemed in Europe and America, Professor at the University of Ghent.

Methods of Testing Steam Engines

By CAPT. H. RIALL SANKEY.



A DISCUSSION of the view that the true way to test steam engines is to give them work similar to that which they are to perform in actual practice, rather than by the use of brakes and similar makeshifts. Captain Sankey is one of the highest authorities in England, and his various papers before the Institution of Civil Engineers are classics. He is Chairman of the committee of that Society on this subject, and will prepare this article as soon as the report of that committee is in.

European Practice in the Use of Superheated Steam

By PROF. SCHROETER.

PROFESSOR SCHROETER is undoubtedly the highest living authority upon this question, to which modern steam engineers look for future improvements in economical engine performance. He has conducted many investigations, both upon engines in actual service and upon the special engines in the mechanical laboratory of the Munich Polytechnic, and will be able to give the latest and best to be had in this line.

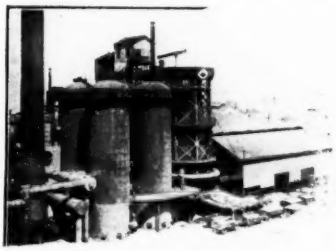
The Economical Performance of the Steam Turbine

By PROF. SCHROETER.

THE same author will give an account of the results of the Elberfeld tests, conducted under his supervision, with a general discussion of the great advantages of the steam turbine.

The Use of Reinforced Concrete in Construction

By MONS. J. BOYER.



THE wide introduction of the use of combined steel and concrete construction is another example of the introduction of mechanical methods into civil structures. Prof. Boyer has available all the data used at the Exposition, as well as from other parts of Europe, and will supply many illustrations.

Industrial Applications of Nickel-Steel

By MONS. C. E. GUILLAUME.

MONS. GUILLAUME'S original investigations into the properties of nickel-steel have attracted much attention, and his papers before the French Academy, of which he is a member, have been widely read and quoted. He is recognized as the highest authority upon the subject.

The Development of Basic Steel-Working in Germany

By E. SCHROEDTER.

A FULL review of this remarkable metallurgical development, by the editor of *Stahl und Eisen*, presenting its economic and technical aspects in the light of his thorough command of the entire history of the industry.

Influence of the Exportation upon the French Iron and Steel Industry

By MONS. TISSERANT.

FRANCE is in the position of a consumer of iron and steel. Her future in this regard is therefore of great importance to the iron-exporting countries—England, Germany, and the United States. Hence the value of this discussion by an eminent consulting engineer of Paris, thoroughly conversant with his country's needs and the economic conditions influencing them.

Applications of Electricity in Iron and Steel Works

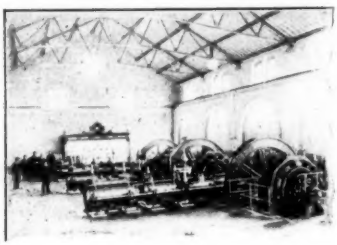
By SYDNEY WALKER.

DR. LOUIS BELL has pointed out that progress in perfecting electrical apparatus has made it so reliable that the only question now is whether it is particularly adapted to the purpose in hand. And nowhere more than in the steel plant is there so full application for its advantages in furnishing cheap motive power, economical distribution, mobility in utilization, and convenience for tractive effort. Mr. Walker has been intimately connected with the advance of the electrical industry in Great Britain, and his paper is enriched with illustrations drawn from all over the world.

Uses of Electric Power in Deep Mining

By RALPH D. MERSHON.

THE farther back toward the source of production an economy is carried, the more widely-reaching are its effects. Mining and iron making are fundamental industries, and for this reason any improvement introduced into their conduct has a pervading influence throughout the engineering trades. Mr. Mershon presents a striking summary of the best electrical practice in mining work, illustrated by typical examples from the leading mines of the world. His association with one of the greatest of American electrical companies assures his mastery of the subject.



The Greatest Electrical Installations of Italy

By ENRICO BIGNAMI.

SIGNOR BIGNAMI, as director of *Elettricitá*, has most comprehensive knowledge of every phase of the development of the industry in Italy. It presents aspects of particular interest on account of the local conditions, Italy having no coal, but abundant water powers available for long-distance transmission. Further than this, that country is now making probably the most exhaustive practical tests of electric traction on trunk-line railways which have ever been attempted. Signor Bignami's article will be richly illustrated.

Utilization of Water Power in Switzerland

By PROFESSOR F. PRASIL.

WATER power, for a time superseded by steam, is returning rapidly to a place of the highest importance. For electricity has removed the limitations which restricted its use.

Progress has been irregular, and in many regions vast funds of natural power are running to waste. Professor Prásil's illustrated articles, showing exactly what has been done in the country where water-power utilization has reached its highest development, will be rich in interest for engineers the world over, wherever similar opportunities exist.

Hydraulic Power and Electrical Applications

By WALLACE C. JOHNSON.

THE activity of attention to the conservation of water-powers is one of the most striking tendencies in engineering work in the United States. Mr. Johnson, who has been connected with the huge work done at Niagara, will review the latest practice, showing the importance of electro-chemical installations in ministering to the ultimate economy of electric-power uses.

Mechanical Drainage of Rotterdam

By ARTHUR MARICHAL.

OWING to the depressed situation of Rotterdam the sewage must be removed entirely by mechanical means, and Mr. Marichal will describe the great piping and pumping plant now being installed there under his supervision. He is an engineer of Belgian birth and education, with fifteen years' experience in the United States, and at present the engineering superintendent of the Continental Worthington Company.

Recent Improvements of Heavy Pumping Machinery

By ARTHUR MARICHAL.

A SECOND paper by the above writer, treating of the latest developments on the Continent, with much data not before published.

The Gold Fields of Western Australia

By A. G. CHARLETON.

BEGINNING with the Kalgoorlie field, Mr. Charleton will describe the peculiar and difficult conditions under which so enormous an output has been secured. He will have the collaboration of the managers of the principal mines. With their wealth of original illustrations, these papers will make the first complete presentation of the interesting and important history of Australian mining and ore treatment. The articles are ready for the press, and their publication will begin in an early number.

I. History, Position, and General Features of the Gold Fields.

The Rise of Kalgoorlie—Early Discoveries of Gold—The Present Gold Fields—Output—Topography and Climate—Their Effect on Gold Occurrence and Extraction—Concentration by Air Currents.

II. General Geology of West Australia and "Dry-Blowing" for Gold.

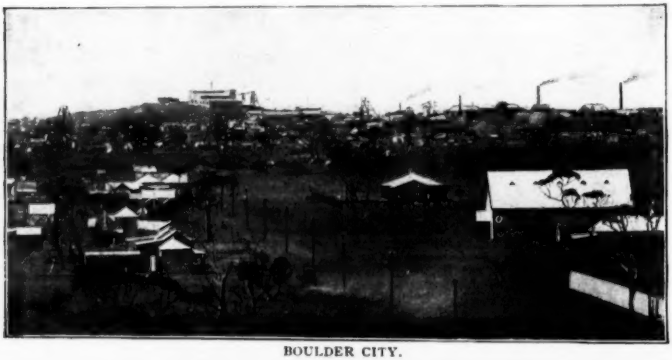
Surface and Deep Geology—The Several Gold Belts—Formation of the Primary Gold Deposits—Internal Evidences—Recent Superficial Deposits—Alluvial Diggings—Underlying Rocks—Working by Dry Blowing—Cement Deposits.

III. Water Problems in the Westralian Field.

Difficulties in the Early Days—Means of Supply—Impounding Reservoirs—The Salt Lakes—Ground Water—Bored Wells—Character of the Water—Purification by Distilling—Cost of Supply—Possibilities of Fluming—Pipe Lines.

IV. Mining and Milling at West Australian Mines.

Characteristic Mines—Extent and Equipment of the Properties—Machinery and Methods—Adaptations to Difficulties of the Country and the Ores—Labor Conditions—Working Results.



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The Work of the Engineer in the Administration of the Exposition

By M. CAYE.

THE administration of the Exposition, considered as a great example of works management, by an engineer of the Ponts et Chaussées, attached to the Bureau of Public Works.

The Practical Applications of Liquefied Gases

By PROF. C. VON LINDE.

A REVIEW of the real uses of liquid air and other gases in contradistinction to the absurd claims made by ignorant or deceiving promoters and speculators. Prof. Linde is the real discoverer of the practical methods of liquefying air, hydrogen, and other so-called "fixed" gases, and is recognized as such in all scientific circles, and stands very high both in European and American opinion

The Artificial Cooling of Dwellings and other Buildings

By PROF. C. VON LINDE.

BY the same author as the preceding paper. He has given this subject much attention, and maintains that buildings may be cooled as successfully in hot weather as they are warmed in cold seasons. He discusses especially the applicability of the plan to hospitals and sanitariums, and his treatment gives another example of the manner in which engineering may become a part of our daily life.

Anglo-American Supremacy in the Industrial Struggle

By C. L. REDFIELD.

A STRIKING argument, following well-known principles of evolution, showing that the mixing of sturdy stocks and residence in favorable climatic conditions give a natural advantage to the English-speaking races. In the modern era, in which commercial and mechanical ability are the elements of natural power, Anglo-American people are likely to dominate the habitable globe.

The Coming Industrial Empire of Puget Sound

By DAVID B. BOGLE.

ONE of the most significant situations in the modern world is to be found on the northwest coast of North America. Vast deposits of iron and coal are just being developed by tireless Anglo-Saxon enterprise. Across the Pacific the enormous markets of the East are newly opened up. Wherever such conditions have existed, foci of industry have been created. Mr. Bogle sketches the shining future of the cities of Pacific North America.

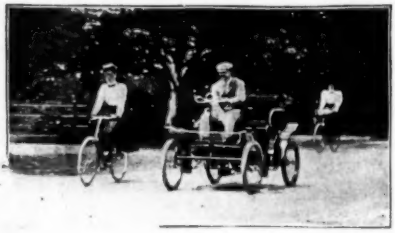
Development of the Petroleum-Driven Automobile

By HERR DAIMLER.

THE material prepared by the late Gottleib Daimler, in accordance with our announcement, made a year ago, has been placed in our hands for the completion of this article, together with portrait and other photographs. The preliminary draft has already been prepared and sent to the younger Daimler for revision and signature.

Light Steam-Driven Automobiles

By MONS. SERPOLLET.



THE article arranged for by visit to Mons. Serpollet at his works in Paris and announced a year ago has been much delayed by long illness. It is now nearing completion and will soon be ready for publication, with many interesting illustrations.

The Engineering Index

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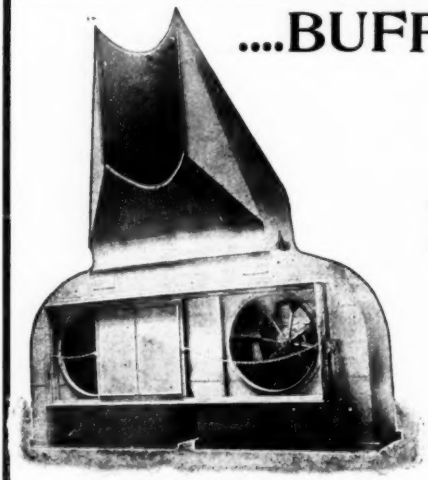

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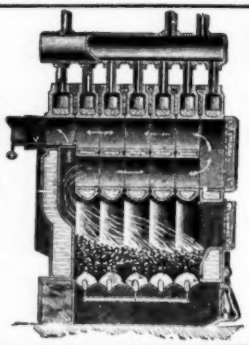

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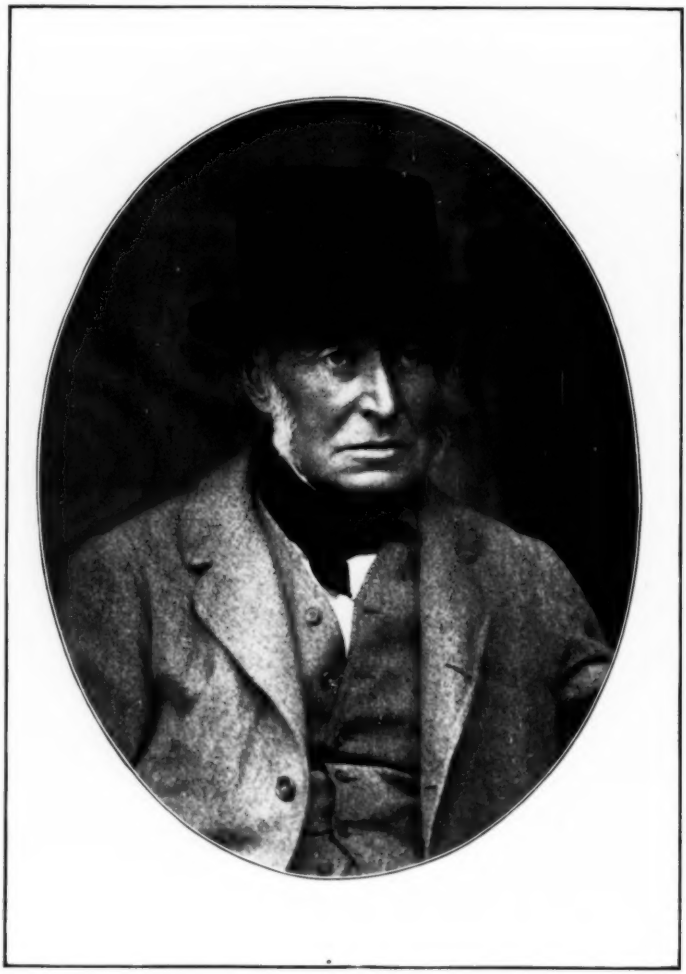

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